III.

THE PLIOCENE RATTLESNAKE FORMATION AND FAUNA OF EASTERN OREGON, WITH NOTES ON THE GEOLOGY OF THE RATTLESNAKE AND MASCALL DEPOSITS.

By JOHN C. MERRIAM, CHESTER STOCK, and C. L. MOODY.

With forty-five text-figures.

CONTENTS.

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INTRODUCTION.

During the summer of 1916 a field party from the Department of Palaeontology, University of California, visited the type localities of Rattlesnake and Mascall formations on the John Day River in eastern Oregon. Five weeks were devoted to an examination of these later Tertiary deposits, primarily for the purpose of securing larger vertebrate collections from the two horizons. The lack of topographic maps and the necessity of spending much of the time in fossil collecting curtailed the geological observations that were made. The facts concerning the geology of the Rattlesnake and Mascall formations should be regarded, therefore, as constituting only a reconnaissance report. While the Mascall deposits yielded also mammalian remains, it seems desirable to reserve the consideration of the Mascall fauna for a later paper.

Since the expedition of 1916 small additions have been made to the collections from the Rattlesnake as a result of further work in the field.

PREVIOUS WORK.

The stratigraphy of the John Day basin, including that of the Rattlesnake and Mascall formations, was discussed by J. C. Merriam[1] in 1901. In a later paper by J. C. Merriam and W. J. Sinclair[2] the known Tertiary faunas of the region were reviewed. The latter paper summarizes the results of faunal work in the John Day basin by former students and lists the assemblages of vertebrates from the various Tertiary horizons in this area. Only a small number of mammalian forms are definitely recorded in this paper from the Rattlesnake beds.

One of the results of the 1916 expedition to eastern Oregon was the discovery of remains of a hyaenarctid bear in the Rattlesnake beds. This material was described in 1919.[3] In a review of the

[1] J. C. Merriam, A contribution to the geology of the John Day Basin, Univ. Calif. Publ., Bull. Dept. Geol., vol.2, pp. 269-314, 1901.

[2] J. C. Merriam and W. J. Sinclair, Tertiary faunas of the John Day region, Univ. Calif. Publ., Bull. Dept. Geol., vol. 5, pp. 171-205, 1907.

[3] J. C. Merriam, C. Stock, and C. L. Moody, An American Pliocene bear, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, pp. 87-109, 1916.

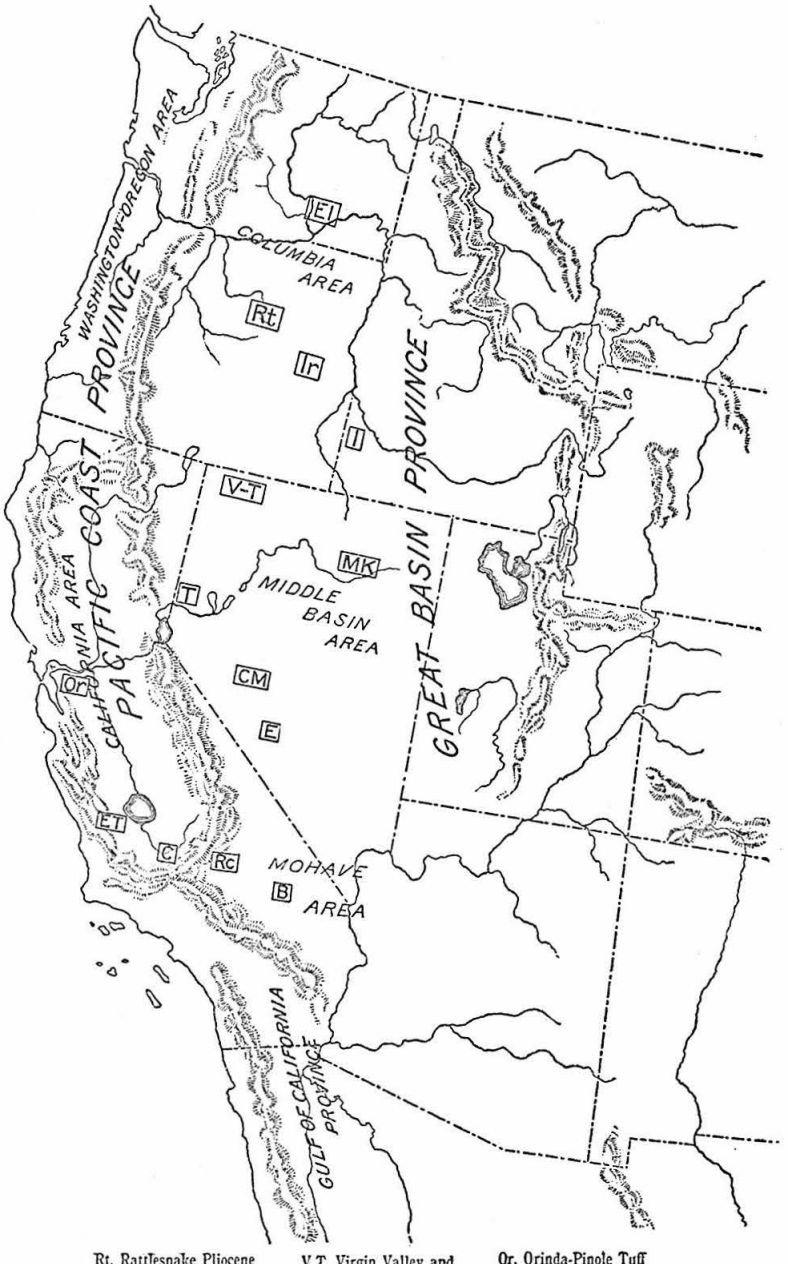


FIG. 1.—Outline map illustrating occurrences of Miocene and Pliocene mammal faunas in Tertiary provinces of the United States west of the Wasatch Range.

Pliocene mammalian faunas from the Pacific Coast and Great Basin provinces, J. C. Merriam[1] gave a list of mammals comprising the Rattlesnake fauna, based principally on the collections made in 1916. Lastly, M. R. Thorpe[2] described the canid genus *Araeocyon* from material said to have been collected in the Rattlesnake and which is now in the Marsh collection at Yale University.

GEOGRAPHIC OCCURRENCE OF THE FOSSIL-BEARING FORMATIONS.

The greater part of the field work of the 1916 party was carried on at the type localities of the Rattlesnake and Mascall formations, situated in Grant County, Oregon, near the point where the East Fork of the John Day River enters Picture Gorge. The region is approximately 5½ miles west of Dayville and occupies parts of townships 125, R. 25 E., and 125, R. 26 E., Willamette base-line and meridian.

Observations of the 1916 expedition were limited to the region lying between Birch Creek and Canyon City. The entire drainage in this area is a part of the system of the East Fork of the John Day, which rises in one of the ridges of the Blue Mountains 30 or more miles to the east of Canyon City and flows in a general westerly direction to the vicinity of Dayville. The course from here to Picture Gorge, a distance of 5 miles, is northwest. At the gorge the river turns sharply to the north and flows in a nearly straight line to its junction with the North Fork at the north end of Turtle Cove. From the town of John Day to Picture Gorge the course of the East Fork is almost entirely within the soft tuffs of the Mascall formation. Only at the "iron bridge," midway between Mount Vernon and Dayville, where the country road crosses to the south bank, has the stream cut down to the underlying Columbia basalt. It thus pursues a subsequent course for 60 miles. At Picture Gorge, however, the river has cut a sharp, rugged canyon with nearly vertical walls rising 500 feet above the stream-bed, directly through a ridge of basalt. Picture Gorge, which takes its name from certain Indian pictographs on a cliff-exposure at the south end, is perhaps 1½ miles long. The course of the river beyond the gorge to its confluence with the North Fork is through the so-called "Big Basin," the bedrock for the most part being in the John Day formation.

The chief tributary of the East Fork is the South Fork, which unites with the former at Dayville. The course of this stream is almost entirely within basalt or pre-Tertiary crystalline rocks. Cummings and Beach Creeks are the chief tributaries which drain the basalt ridge to the north of the East Fork. Streams to which frequent reference will be made in subsequent discussion are Cottonwood Creek, flowing from the south to meet the East Fork at Mascall

[1] J. C. Merriam, Relationships of Pliocene mammalian faunas from the Pacific Coast and Great Basin provinces of North America, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, pp. 421-443, 1917.

[2] M. R. Thorpe, Two new fossil Carnivora, Amer. Jour. Sci., ser. 5, vol. 1, pp. 477-479, 1921.

Ranch; Rattlesnake Creek, entering the mouth of Picture Gorge, and Little Rattlesnake, its tributary; Rock Creek, which in its lower course closely follows the Mascall-basalt contact west of Picture Gorge; and Mountain and Birch Creeks, the main tributaries of Rock Creek. These streams all drain the region south and southwest of the sharp northern bend in the East Fork at Picture Gorge. Practically all the tributaries may be classed as perennial streams; in fact so dry is the summer climate that the John Day River in September shrinks to brook-like proportions.

A dominant control of the present topography within the East Fork valley is undoubtedly exerted by the Columbia lava, but of great importance in determining the local relief is a resistant rhyolite flow which occurs at a high horizon in the Rattlesnake formation. This serves as a protection to the easily reducible beds which lie at lower horizons, with the result that buttes determined by "rim-rocks" are characteristic features of the physiography. In some cases, notably in the buttes north of Dayville, the gravels attain a considerable thickness above the rhyolite, while in others, particularly in the vicinity of the type section of the Rattlesnake, the lava alone forms the summit of the buttes. To the south of the main valley the rhyolite thins and gradually disappears, so that the hills in this direction take on a rounded and smooth appearance due to the ease with which the "loose" gravels of the Rattlesnake and the soft tuffs of the Mascall break down under the forces of erosion. These rounded hills, however, soon lead to mountains of considerable relief which constitute the divide between the John Day and Malheur drainage systems. The basalt and the crystalline pre-Tertiary rocks of this range give rise to a rugged topography which stands in marked contrast to the low relief of the rather even, rolling lava plateau bounding the valley of the East Fork on the north.

GEOLOGIC SECTION AT TYPE LOCALITIES OF RATTLESNAKE AND MASCALL FORMATIONS.

In the columnar section, figure 2, are given the formations occurring near the type localities of the Rattlesnake Pliocene and Mascall Miocene. Figure 3 sets forth the geologic relations of the formations at these localities.

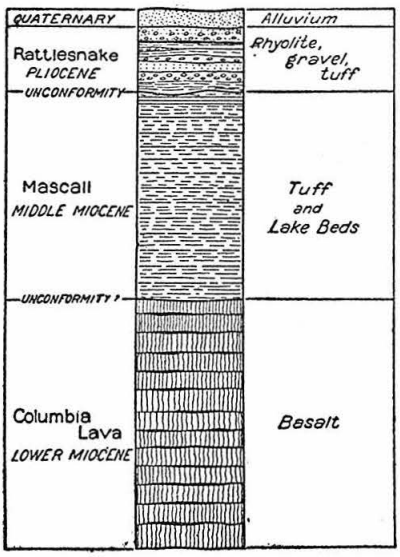


FIG. 2.—Columnar section showing formations occurring near type localities of Rattlesnake Pliocene and Mascall Miocene on Rattlesnake Creek, John Day Basin, Oregon.

MASCALL FORMATION.

The Mascall formation is represented only in the synclinal depression in the Columbia basalt that extends along the John Day River from Canyon City westward for at least 50 miles. In no portion of this region are the Mascall beds present over an area more than 5 miles wide. A mile or two west of the junction of Mountain Creek with Rock Creek the Mascall is overlapped by the Rattlesnake gravels, so that it is not known to extend farther west than to the vicinity of Antone. The eastward limit of the formation is reached at Mount Vernon. The present distribution of the Mascall is evidently contingent upon the protection afforded the easily reducible tuffs by the basalt walls of the East Fork syncline. The formation

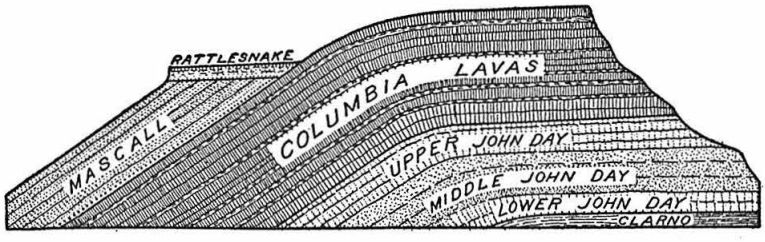


FIG. 3.—Section showing geologic relations of Rattlesnake Pliocene and Mascall Miocene as exposed at type localities, John Day Basin, Oregon.

was once undoubtedly of much greater extent, probably overlying a considerable part of the lava plateau north of the valley. Thus Collier[1] correlates the Dalles group with the Mascall and states that outliers of the latter are to be seen between Condon and the Columbia River. Exposures of the Mascall on Cottonwood Creek, on the south limb of the syncline, do not at all indicate marginal deposition, from which a former considerable southern extension may be inferred. South of the Blue Mountains exposures with a Mascall fauna are to be found over an extensive area.

The relation of the Mascall beds to the Columbia lava is significant, as it has a very definite bearing upon the age of the vast lava fields of the northwest and hence upon the geologic history of the continent. Conditions in the vicinity of Picture Gorge are exceptionally favorable for a close determination of this important date, for here the John Day beds bearing an upper Oligocene fauna underlie the lava with a possible erosion period intervening. Directly above the basalt appears the Mascall formation, which yields a middle Miocene mammalian fauna.

Consideration of the period of extravasation of the lava is contingent not only upon the recognition of Oligocene age for the John Day and middle Miocene age for the Mascall, but also upon the

[1] A. J. Collier, The geology and mineral resources of the John Day region, Oreg. Bur. Mines and Geol., Mineral resources of Oregon, vol. 1, No. 3, p. 19, 1914.

assumption of conformity between the Mascall and the basalt.[1] Certain observations tend to indicate that an interval of erosion and possibly a local deformation of the lavas may have occurred before the accumulation of the Mascall tuffs. This evidence is based upon a local variation of Mascall sediments along the strike in company with frequent changes in thickness below a known persistent horizon in the tuffs.

In the rhyolite-covered butte west of Picture Gorge the basal member of the Mascall is a coarse, slightly concretionary, very yellowish tuff bearing occasional small blocks of basalt. West of McDonald's ranch, at the union of Birch Creek and Rock Creek, 4 miles from Picture Gorge, a section of the Mascall is exposed which possesses at least three thick members unknown in the type section. All of these strata are below a massive, white, earthy tuff, termed in the field the "mammal horizon" because of its comparative richness in fossil vertebrate material. The sediments near the McDonald ranch are (*a*) a series of red tuffs approximating 100 feet in thickness, (*b*) a grayish-blue sand bearing occasionally dark carbonaceous beds, 50 feet, and (*c*) a very light, pithy, thin-bedded shale of a walnut-brown color, bearing frequent impressions of stems and occasional rude traces of leaves. The latter member may reach a thickness of 40 feet. On the east side of the John Day River, opposite the Mascall ranch house, appear plant-bearing shales and gypsiferous strata at apparently a lower horizon than is found at the type section. It would thus appear that the surface on which the Mascall sediments accumulated was at least locally irregular. It is probable that the lava now exposed on the west wall of Picture Gorge formed a low hill at the beginning of Mascall time and that the plant-bearing beds were deposited on its flanks in lacustrine basins. The suggestion of pre-Mascall disturbances of the basalt consists in the fact that the present south surface of the basalt slope north of the East Fork, which seems to pass under the Mascall beds, truncates the individual flows of lava exposed in Picture Gorge. This truncation is expressed in the topography of the slope by a step-like appearance, occasioned by the wearing back of certain less-resistant lava beds due to sapping action of the softer tuffs intercalated between the flows. If these conditions are considered sufficient evidence upon which to base an unconformity, then the period of extravasation of the lavas must be somewhat earlier in the early middle or lower Miocene.

The vertebrate remains of the Mascall were obtained at a single horizon, so that a definite datum plane appears to which other horizons may be referred. This is a massive, white, earthy tuff with no trace of bedding planes. It fractures irregularly into great blocks

[1] A. J. Collier, *ibid*, p. 17, 1914.
J. C. Merriam, Univ. Calif. Publ., Bull. Depart. Geol., vol. 2, p. 306, 1901.

which soon disintegrate, leaving a vertical or overhanging wall, from 20 to 50 feet high. An important element in the preservation of this wall is a hard, yellowish, concretionary tuff, which immediately overlies the earthy fossiliferous zone and weathers into very rough surfaces. These two beds, the concretionary tuff and the earthy tuff, are the most persistent of all the members of the Mascall formation. Their characters are very constant and a number of exposures are to be found from the lava-topped buttes of the type section eastward to Wilson's ranch, a distance of about 12 miles. The "mammal horizon" forms the white bluff in the butte of the type section; its dip of 18° carries it to the level of Rattlesnake Creek at this point, where it appears as the south bank of that stream. The outcrop then pursues a straight line to the Mascall ranch house, appearing in the south bank of the John Day River. Near Mascall's house the beds are covered by terrace deposits and from here to Dayville the outcrops are concealed under Recent and Pleistocene deposits of the river. At Dayville, however, the tuffs are again evident on the north side of the John Day, where they appear somewhat nearer the base than at the type locality, although they are otherwise identical in character with the beds at the Mascall ranch. The strike carries the horizon across the river somewhat below MacRae's ranch. Two miles east of its appearance on the south bank of the river the horizon passes under Rattlesnake gravels and does not reappear to the east. In this last exposure the admixture of siliceous shale with the concretionary tuff layer, and also subordinately with the earthy tuff, indicate marginal lacustrine conditions.

The section from the "mammal horizon" to the base of the formation, immediately to the west of Picture Gorge, consists of alternating yellowish and grayish tuffs. The variations in the basal members of the tuff series east of Picture Gorge and on Rock Creek west of McDonald's ranch have already been mentioned. In the vicinity of Belshaw ranch, 12 miles east of Dayville, the basal portion of the Mascall is lithologically different from the lower horizons of the section farthest west. Sandstones and thick-bedded, white tuffaceous shales bearing numerous, well-preserved plant remains and occasional fish remains replace the coarse yellow tuffs of the type section and the carbonaceous beds of Rock Creek. Particularly prominent is a bluish-gray, medium-grained, massive sandstone overlying the plant-bearing strata which weathers into fantastic pinnacles and crags on dip outcrops and into irregular, cavernous openings in cliff sections. A sandstone of this peculiar character overlies the "mammal horizon" immediately north of MacRae's ranch, 3 miles east of Dayville. Indications are thus that the plant-bearing beds near the Belshaw ranch are not far from the horizon of the fossiliferous tuffs in

the vicinity of the Mascall ranch. On the south side of the John Day in the vicinity of the Belshaw ranch, the Mascall formation contains several horizons of cross-bedded sandstones, grits, and conglomerates, the material of which was derived not from the Columbia lava, but apparently from pre-Tertiary rocks of the region to the east.

Above the "mammal horizon" the Mascall beds at the type section are chiefly light-colored tuffs of medium to fine grain. Rarely, as at the Mascall outcrop on the second butte west of Picture Gorge, small lenses of fine gravel appear intercalated with the tuffs. Plant remains were found at two horizons above the mammal-bearing beds. The first occurrence was in a brownish shale alternating in thin layers with a grayish-blue sandstone, 200 feet above the mammal horizon. The second plant locality was found 1,000 feet above the first in a bluish-gray, arenaceous shale.

The following columnar section was observed at the type locality of the Mascall formation west of Picture Gorge:

	Feet.
1. Uppermost deposit. Gray, yellow, and brownish tuffs	400
2. Bluish-gray, arenaceous shale. Leaf impressions	2
3. Medium-grained, yellowish, grayish, reddish, and greenish tuffs, with occasional gravel lenses	600
4. Brownish shale finely interbedded with bluish sandstone. Leaf impressions	5
5. Yellowish, medium-grained tuff	200
6. Concretionary, yellowish tuff giving rugged outcrops and rough surfaces	20
7. Massive earthy tuff breaking irregularly and forming bluff-outcrops. Mammal horizon	30
8. Alternating yellowish, reddish, and grayish fine-grained tuff	110
9. Bluish, fine pumiceous sand	3
10. Earthy, white tuff	20
11. Medium-grained, yellowish and grayish tuffs alternating	650
12. Basal deposit. Yellowish tuff with basalt blocks up to a foot in diameter	50
Total	2,090

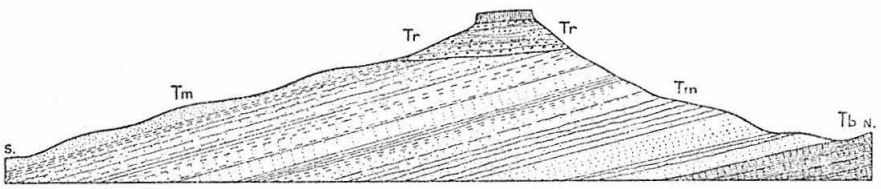


FIG. 4.—Section through Tertiary formations near type localities of Rattlesnake Pliocene and Mascall Miocene. *Tb*, Columbia basalt; *Tm*, Mascall; *Tr*, Rattlesnake.

A poor grade of lignitic coal has been found in lower horizons of the Mascall at various localities in the valley of the East Fork. Basalt of an olivine-free type[1] is found interbedded with Mascall tuffs within the basin of Rock Creek. The flows are lenticular and do not reach as far east as Picture Gorge. The basalt exposed on Rattlesnake Creek and Birch Creek has been brought into its present position by a small strike fault.

[1] F. C. Calkins, A contribution to the petrography of the John Day basin, Univ. Calif. Publ., Bull. Dept. Geol., vol. 3, pp. 165–166, 1902.

GEOLOGIC RELATIONS OF RATTLESNAKE FORMATION.

Unconformably overlying the Mascall beds throughout the basin of the East Fork is an extensive series of gravels and tuffs with an intercalated bed of rhyolite, constituting the Rattlesnake formation. The Rattlesnake occasionally overlaps the Mascall and lies directly upon the basalt; from Antone to Mitchell it lies successively upon basalt, pre-Tertiary, and Clarno; on the south side of the John Day River from the "iron bridge," 8 miles east of Dayville, to Canyon City, it rests upon crystalline rocks of pre-Tertiary age. The Rattlesnake is not certainly known outside the basin of the East Fork, although rhyolite similar to that characterizing the formation is known from the Crooked River region.[1] It is evident that the northern limit of the formation was not far from its present extent in the valley of the East Fork, for in the vicinity of Picture Gorge and in the area from Dayville to Mount Vernon, the rhyolite, lying almost horizontal, abuts upon dip slopes of the basalt with a southerly inclination of 18°. The southern extension was probably somewhat greater than it is at present. The gravels thicken markedly south of the river. This is especially noticeable on Cottonwood Creek and in the hills southwest of Dayville. The rhyolite wedges out on the west side of Cottonwood, and appears as a thin stratum of reddish ash in the large triangular outcrop facing Dayville on the southeast. It would thus appear that the rhyolite was poured out over an ancient flood-plain of the John Day River, and that it never extended laterally beyond this limit.

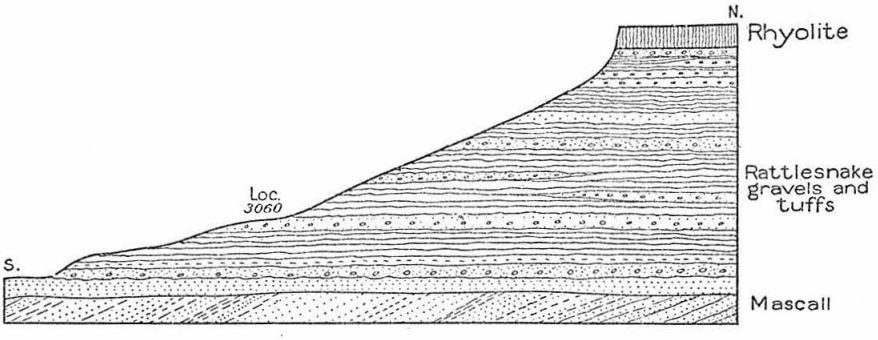


FIG. 5.—Section showing relationship of Rattlesnake rhyolite, gravels, and tuffs to the Mascall formation. Note stratigraphic position of U. C. vertebrate fossil locality 3060.

The area of Rattlesnake exposed in the butte west of Picture Gorge has generally been termed the type section, and although it really represents but a small part of the entire succession within the formation, it was subjected to more careful study than elsewhere, due to

[1] I. C. Russell, Preliminary report on the geology and water resources of central Oregon, U. S. Geol. Surv. Bull. 252, pp. 59–60, 1905.
C. Stock and E. L. Furlong, Univ. Calif. Publ., Bull. Dept. Geol., vol. 13, p. 312, 1922.

the presence of mammalian fossils in the tuff and in the gravel. Great local variations occur in the sedimentary portion of the formation. Beds of coarse gravel frequently alternate with the finest earthy tuffs; lenses of one type of clastic material are abundantly included within those of another type, and occasional transitions of the fine tuff into gravel are to be noted along the strike. The following columnar section was measured west of the saddle dividing the two areas of rhyolite at the type locality:

	Feet.
1. Summit of section. Rhyolite. Massive flow with tuffaceous phases, irregular beds of lapilli near base, pumiceous fragments throughout	28
2. Rhyolitic débris. Surface shows abundance of round basaltic pebbles	120
3. Gravel, cross-bedded sandstone, and thin lenses of brownish tuff	15
4. Brown, earthy tuff with concretions	5
5. Medium-grained grit in lenticular masses	3
6. Cross-bedded sandstones, brown earthy tuff with irregular concretions, well indurated. Locality 3060 U. C., with *Pliohippus*, *Prosthennops?*	9
7. Brown and yellowish tuff and gravel	14
8. Tuff, cross-bedded sandstone, and basaltic gravel interdigitating	25
9. Massive, buff tuff with several indurated layers. Locality 3235 U. C., with *Teleoceras*	17
10. Rounded, basaltic gravel	11
11. Buff tuff	3.5
12. Basaltic gravel, well-rounded and sorted	4.5
Total	255

Without exception the pebbles in the gravel at the type locality show much evidence of continued water-wear; the majority of them may be termed "well-rounded." Petrographically the pebbles are identical with the Columbia basalt and it is practically certain that the great lava sheet has been the source of the coarser detrital material of these beds. Closely associated with the gravels are cross-bedded, rather quartzose sandstones and somber-colored tuffs. The sources of these materials are not definitely known, but it seems probable that the sandstones have been derived from the area of crystalline rock southeast of Picture Gorge, while the tuffs may represent the finer material of volcanic eruption, transported to its present position in part by winds and in part by the Tertiary stream on whose flood-plain the gravels were accumulating. The possibility that the tuffs may in part represent reworked Mascall sediments must not be overlooked.

The induration of some of the Rattlesnake beds is extreme; both gravel and tuff may be locally very hard. The sixth and tenth

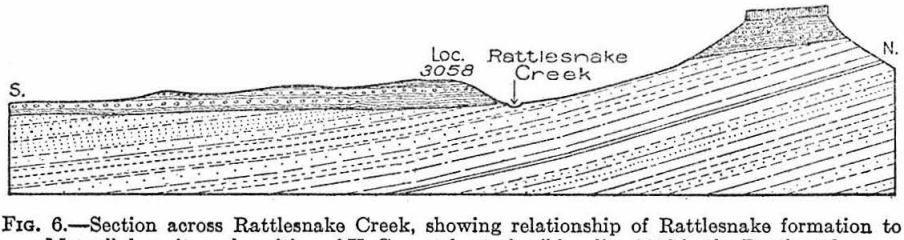


FIG. 6.—Section across Rattlesnake Creek, showing relationship of Rattlesnake formation to Mascall deposits and position of U. C. vertebrate fossil locality 3058 in the Rattlesnake.

members of the columnar section given above are particularly well cemented by the infiltration of silica and carbonate of lime.

In general the Rattlesnake west of Picture Gorge has been eroded down to the rhyolite flow. A perfectly even, gently sloping surface appears continuously from the butte of the type section to a point several miles beyond Birch Creek; the rhyolite throughout this extent is a "rim-rock" with vertical walls from 10 to 50 feet in height. On Cottonwood Creek and in practically all Rattlesnake

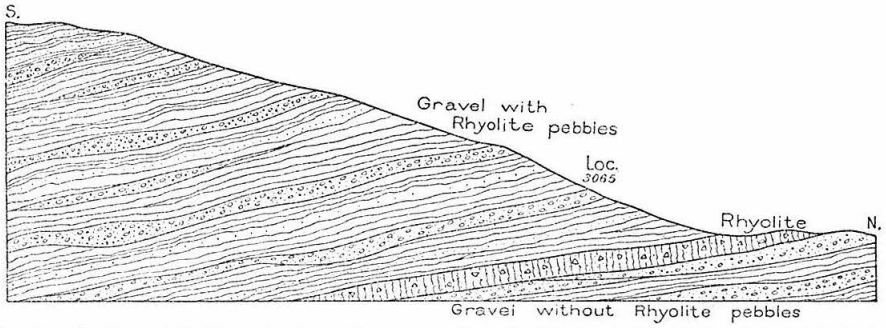


FIG. 7.—Section of Rattlesnake formation exposed on Cottonwood Creek, showing particularly gravel with rhyolite pebbles resting on rhyolite and position of U. C. vertebrate fossil locality 3065.

areas east of Picture Gorge, however, a very considerable thickness of gravels overlies the rhyolite. On Cottonwood Creek the gravels above the rhyolite are 450 feet thick, and although olivine basalt, evidently derived from the Columbia flows, forms by far the largest number of pebbles of the coarser beds, other pebbles appear in abundance. Granitic and quartz pebbles are not at all uncommon, while rhyolite fragments of a character identical with that of the rhyolite flow of the Rattlesnake are frequently to be observed. Tuffs interbedded with the gravels above the rhyolite indicate that there is no great lapse of time between the upper and lower horizons of the formation. North of Dayville the upper gravels are developed to a maximum thickness of 200 feet; at Mount Vernon they are less than 100 feet thick.

The rhyolite flow which characterizes the Rattlesnake throughout its extent varies in thickness up to 50 feet. The wedging out of the flow on the south side of the river has been mentioned. From Dayville to Mount Vernon no rhyolite is known on this side of the river, but "rim-rocks" of the characteristic brownish-red lava are common south of the stage road leading from Mount Vernon to Canyon City. The rhyolite is always massive and bears no traces of fluxion lines or other banding common to acid lavas. It breaks with conchoidal fracture on a large scale. Commonly great irregular columns averaging 20 feet across are produced on the margins of the "rim-rocks." On weathered surfaces the rhyolite is uniformly of a reddish-brown

color, but on freshly broken surfaces it appears bluish-gray. Phenocrysts are limited to occasional small, untwinned feldspars; the greater part of the rock is felsitic. Angular lapilli and fragments of pumice are abundant throughout the lava and may be so concentrated locally that the felsitic matrix nearly disappears. Near the base of the rhyolite, pebbles from the underlying gravels are frequently seen in little black pockets in the grayish lava. In the vicinity of Mount Vernon on Beach Creek unusual jointing phenomena are to be observed in the rhyolite. Columnar structure of a radial type is perfectly developed, producing stony rosettes of large size. The center of the rosette structure is usually near the middle height of the flow, which is 40 feet thick in this region. The columns are well formed and extend to the upper and lower limits of the flow, with an average diameter of 15 inches. About 2 miles southwest of the Wilson ranch and 5 miles east of Dayville, a remarkable exposure of Rattlesnake gravels occurs lying on northerly dipping basalt. These gravels form vertical cliffs, estimated as at least 200 feet in height, and weather into picturesque crags and pinnacles. The horizon of the rhyolite flow was not recognized in this exposure, and it may be that neither the lava nor its acid tuff extended so far south. The formation at this point is estimated to be 400 feet thick.

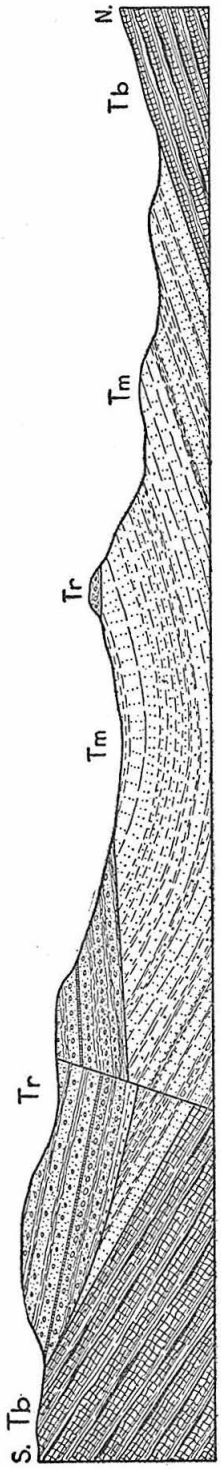
The maximum thickness encountered in the Rattlesnake was on Cottonwood Creek, where the formation from the basal beds to the top of the upper gravels reaches a thickness of 900 feet.

The surface upon which the Rattlesnake gravels and tuffs accumulated was apparently one of considerable relief, though perhaps of gentle contour. At Picture Gorge not over 50 feet of gravels separate the rhyolite flow from the basalt, while on Cottonwood Creek from 400 to 500 feet of tuffs and gravels lie below this horizon. This represents a thickening of from 350 to 450 feet in a distance of less than 2 miles. The Rattlesnake-Mascall contact in the type section dips decidedly toward the south, and, as the Rattlesnake beds are very slightly disturbed, this becomes an index of pre-Rattlesnake relief. The unconformity between the Rattlesnake and Mascall is one of the most clear-cut geologic features of the John Day basin; the discordance of dip varies from 6° to 15°, and the sharp distinction in the two types of sediments usually permits an easy delimitation of the formations.

STRATIGRAPHIC POSITION OF HIPPARION.

The genus *Hipparion* has at various times been listed with the fauna of the Mascall, but results of the present investigation sustain the conclusion, suggested by Merriam and Sinclair,[1] that this form

[1] J. C. Merriam and W. J. Sinclair, Tertiary faunas of the John Day region, Univ. Calif. Publ., Bull. Dept. Geol., vol. 5, p. 198, 1907.



is confined to the Rattlesnake formation. Careful search throughout the type locality of the Mascall failed to reveal more than one zone yielding mammalian remains. This horizon is in the type section, approximately 900 feet from the base of the formation. Localities from which Mascall fossils have been collected west of Rattlesnake Creek on the road to Antone, and in the vicinity of Birch Creek, are in this horizon, but have been brought to their present position by post-Rattlesnake faulting. Fossils were frequently found in place in this "mammal horizon" at numerous points between Birch Creek and MacRae's ranch, a distance of 15 miles, but in no case was a horse, more advanced than *Merychippus*, found embedded in the tuff. On the other hand, *Hipparion* was found once actually in place in Rattlesnake tuff and was frequently discovered with *Pliohippus* lying on Rattlesnake gravel and tuff. All known occurrences of *Hipparion* were on or beneath Rattlesnake exposures. Under these conditions the occasional occurrence of a tooth of *Hipparion* resting on Mascall tuff would not seem to negative the evidence indicating restriction of this group to the Rattlesnake formation in this region.

STRUCTURE.

The valley of the East Fork of the John Day River as far down as Picture Gorge appears to be a long, narrow syncline determined by a rather sharp flexure in the Columbia lava and the Mascall tuffs. This structural trough is of variable width, but never exceeds 5 miles in lateral dimension; its length is disproportionately great, being at least 50 miles. In the vicinity of the type section both limbs of the syncline are basalt, but pre-Tertiary rocks appear as the south limb, both east and west of a basalt outcrop of approximately 12 miles in length. The dip on the north limb of the syncline does not vary greatly from 18°, while on the south limb, as seen along Cottonwood Creek, the basalt dips 30° north.

FIG. 8.—Diagrammatic section showing faulting and relationship of beds on Birch Creek, Grant County, Oregon. *Tb*, Columbia basalt; *Tm*, Mascall; *Tr*, Rattlesnake.

Merriam[1] mentions exposures, reported to be lava, in nearly vertical position high up on the southern slope. Collier[2] reports the lava as vertical "at Flat Creek about 8 miles east of the Picture Gorge locality and 1 mile south of the John Day River."

Faulting has affected the valley of the East Fork, but it is rather subordinate as a structural feature. Faults are to be seen in section on Birch, Rattlesnake, and Cottonwood Creeks. The diagrammatic section (fig. 8) shows the relations found on Birch Creek. The rhyolite of the Rattlesnake is here vertically displaced through a distance of 200 feet, the north side of the fault being the downthrown side. On Rattlesnake Creek basalt is exposed by faulting, but the actual throw is not at this point determinable. On Cottonwood Creek the rhyolite is displaced vertically 100 feet, but here the down-throw is on the south side of the fault. These exposures are apparently on the same fault. Thus there seems to be indicated a motion on the fault-plane resulting in an uplift on the north side with a rotation in an east-west direction, this secondary tilting being to the west.

AGE AND RELATIONSHIPS OF THE RATTLESNAKE FAUNA.

The Rattlesnake fauna has unusual significance owing to exceptional clearness of stratigraphic relations of the beds in which it occurs. As indicated in the discussion of the geology of the fossil-bearing beds at the type localities of the Rattlesnake and Mascall, the Rattlesnake formation rests in marked unconformity upon the Mascall, which contains a mammalian fauna of middle or upper Miocene age. Through the accumulated Rattlesnake deposits deep cañons have been cut, and in the lower reaches of these excavations are deposits containing a Pleistocene fauna. The age of the Rattlesnake formation is therefore limited on one side by a period of erosion and deformation succeeding accumulation of the Mascall Miocene, and on the other side by a period of erosion preceding accumulation of deposits of Pleistocene age.

The following list of mammals, representing the Rattlesnake fauna, is based chiefly on materials collected in these deposits by the expedition of 1916:

Rattlesnake Fauna.

Carnivora:
- Canis?, cf. davisi Merriam.
- Amphicyonid or Ursid sp.
- Indarctos (?) oregonensis Merriam, Stock, and Moody.
- Indarctos (?) sp.
- Mustela n. sp.
- Felid sp. A, large.
- Felid sp. B, small.

Rodentia:
- Otospermophilus gidleyi n. sp.

Lagomorpha:
- Hypolagus, near vetus (Kellogg).

Edentata:
- Megalonychid? gen. and sp. indet.

Proboscidea:
- Proboscidean remains.

[1] J. C. Merriam, Univ. Calif. Publ., Bull. Dept. Geol., vol. 2, p. 305, 1901.
[2] A. J. Collier, Ore. Bur. Mines and Geol., Mineral Resources of Oregon, vol. 1, No. 3, p. 17, 1914.

Rattlesnake Fauna—Cont.

Equidae:
- Plohippus spectans (Cope).
- Hipparion sinclairi (Wortman.)
- Hipparion occidentale Leidy.
- Hipparion leptode Merriam or
- Hipparion occidentale Leidy.
- Hipparion anthonyi Merriam.

Rhinocerotidae:
- Teleoceras?, near fossiger (Cope).

Suidae:
- Prosthennops? sp.
- ?Platygonus rex Marsh.

Camelidae:
- Pliauchenia? or Alticamelus?

Bovidae:
- Sphenophalos sp.
- Ilingoceros or Sphenophalos? sp.

The fauna of the Rattlesnake deposits is widely removed from the mammalian assemblage known from the Mascall Miocene and from the Virgin Valley fauna. It is also distinctly separated from such upper Miocene faunas known in the Great Basin province as the Barstow and the Cedar Mountain. There is certainly a closer relationship between the Rattlesnake and Ricardo faunas than exists between the latter and either the Barstow or the Cedar Mountain fauna. The Ricardo is generally regarded as being of lower Pliocene age.

A comparison between the Rattlesnake fauna and that of the Ricardo suggests that the former is more advanced. The horses of the Rattlesnake include *Pliohippus* and *Hipparion*, genera that are known also from the Ricardo. In size and in complexity of the enamel pattern of the cheek-teeth some of the Oregon hipparions seem not far removed from *Hipparion mohavense* of the Ricardo Pliocene. On the other hand, material is available representing types larger than *H. mohavense*, and at least one form is known, namely, *Hipparion anthonyi*, in which a stage of complication of enamel pattern in the cheek-teeth is reached which exceeds that found in the typical *Hipparion* from the Ricardo beds. Among the artiodactyls we should note the contrast between the forms of *Merycodus* from the Ricardo and the larger antelopes related to *Sphenophalos* and *Ilingoceros* of the Rattlesnake fauna. The faunal difference between the Rattlesnake and Ricardo may be due to geographic variation or to earlier appearance in the northern region of the Great Basin province of immigrants reaching North America in Pliocene time. It is probable that the difference between the Rattlesnake and Ricardo faunas is due in part to difference in stage of evolution, with the Ricardo as the earlier stage. It is not probable that the difference amounts to more than a small portion of a geologic period.

Comparison between the mammalian assemblages from the Rattlesnake and from the Thousand Creek of Nevada suggests that the Rattlesnake fauna makes a somewhat nearer approach to the Thousand Creek than does the Ricardo. Species of *Pliohippus* and *Hipparion* occur also at Thousand Creek, and one form, *Hipparion leptode*, seems rather closely related to a type of horse from the Rattlesnake. In both the Rattlesnake and Thousand Creek faunas the genus *Merycodus* is absent, or at least is not known by available

materials at the present time, while larger antelopes of the *Sphenophalos* and *Ilingoceros* types are present.

The *Pliohippus* forms among the horses of the Rattlesnake are much like those from the *Pliohippus coalingensis* zone of the Etchegoin in the Pacific Coast province, while *Hipparion* species in the Oregon fauna show some resemblance to a species from the Hipparion zone of the Pacific Coast province. Antelope remains from the Orinda-Pinole Tuff Pliocene near Pinole, California, bear some resemblance to types known from the Rattlesnake and Thousand Creek horizons.

DESCRIPTION OF FAUNA.

CARNIVORA.

Canis ? cf. davisi Merriam.

A fragment of a lower jaw, No. 22384, containing a lower carnassial (fig. 9.) from U. C. locality 3048 of the Rattlesnake formation represents a canid type similar to one very imperfectly known from the Pliocene of the Great Basin region. The metaconid has approximately the size of that in the timber wolves of the *Canis* group. The heel is shorter, but not relatively shorter, than in the timber wolves, and the hypoconid is large. The entoconid region is imperfectly preserved, but this tubercle was apparently

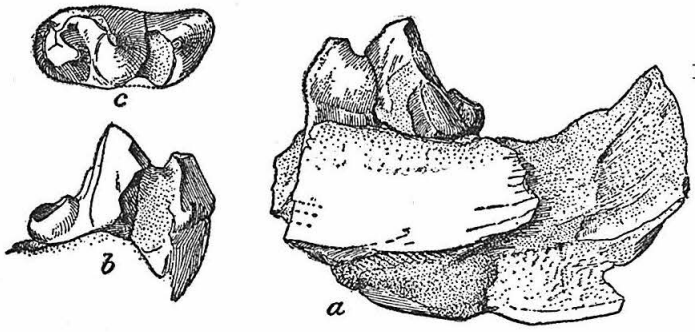


FIG. 9.—*Canis?* cf. *davisi* Merriam. $M\bar{1}$, No. 22384 U. C. C.; *a*, inner view; *b*, outer view; *c*, occlusal view; ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

very small in comparison with the size of the hypoconid. No. 22384 may represent an amphicyonine or may belong to a type which has been referred to as *Canis? davisi*, known from the Thousand Creek Pliocene of Nevada.

Measurements (in millimeters) of No. 22384.

$M\bar{1}$, greatest antero-posterior diameter	23.8
$M\bar{1}$, greatest transverse diameter across metaconid	10

Amphicyonid or Ursid sp.

A fragment of a lower jaw, No. 22462 (fig. 10), from U. C. locality 3045 in the Rattlesnake formation, contains a single molar tooth situated immediately in advance of the base of the coronoid process. There is no alveolus of the tooth posterior to the individual present and a portion of the alveolus anterior to this tooth shows a narrow posterior root resembling the form of posterior root of $M\bar{2}$ more closely than that of $M\bar{1}$ accompanying tubercular molars as distinctly of a crushing type as the molar in No. 22462. The tooth present is either $M\bar{3}$ or $M\bar{2}$. It shows a form corresponding in general to that of $M\bar{2}$ of the bears. In the trigonid portion the protoconid and metaconid are small, very low, and are connected lightly by a transverse ridge. Anterior

to the protoconid and metaconid there is a wide shelf approximating in area that anterior to the protoconid and metaconid of the bears, but no distinct paraconid is shown. The posterior or talonid region of the tooth is large and the tubercles are very low.

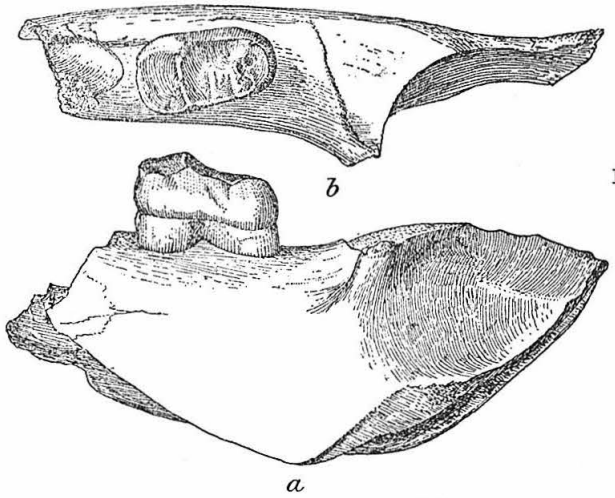


FIG. 10.—Amphicyonid or Ursid sp. Fragment of jaw with inferior molar tooth, No. 22462 U.C.C.; *a*, outer view; *b*, occlusal view; ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

This tooth does not correspond to any $M\bar{3}$ known to the writers in either the ursid or canid group. The characters possessed by this specimen are strikingly similar to those of $M\bar{2}$ of the bears, but there is no suggestion of an alveolus of $M\bar{3}$ and no member of the bear group from the Tertiary has a $M\bar{3}$ as advanced as this tooth. The molar is somewhat longer antero-posteriorly and relatively narrower than $M\bar{2}$ or *Ursavus*, and is also larger than any *Ursavus* form known to the writers. The tooth in No. 22462 is longer antero-posteriorly, narrower, and more specialized for the exclusive function of crushing than in $M\bar{2}$ or $M\bar{3}$ of the *Amphicyon* forms known to the writers. This tooth approaches in some respects $M\bar{2}$ of *Simocyon*, but is somewhat larger and the talonid region is more fully developed. With $M\bar{2}$ of *Simocyon* the specimen represented by 22462 has in common the fact that there is no evidence of another tooth posterior to it.

Amphicyon sinapius Matthew[1] from the Colorado Loup Fork has a more typical Amphicyon-like form, and the heel region is entirely different from that of this species.

Amphicyon amnicola Matthew and Cook[2], described from the Snake Creek beds, is a large form with large and broad $M\bar{2}$ and a large two-rooted $M\bar{3}$. As nearly as can be judged $M\bar{3}$ of *Amphicyon amnicola* had dimensions close to those of the molar tooth represented in the specimen from the Rattlesnake. It is possible that No. 22462 is related to the Snake Creek species. It is necessary to await the discovery of additional material before forming a final judgment as to the affinities of this form.

Measurements (in millimeters) of No. 22462, $M\bar{2}$ or $M\bar{3}$.

Antero-posterior diameter	18.8
Greatest transverse diameter	10.5
Antero-posterior diameter of trigonid	12.1
Antero-posterior diameter of talonid	6.7
Width of lower jaw at anterior base of coronoid process	19

Indarctos(?) oregonensis Merriam, Stock, and Moody.

Indarctos (?) oregonensis Merriam, Stock, and Moody, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, pp. 87-109, 1916.

Type Specimen.—No. 22362, University of California collections in Museum of Paleontology. Specimen from Rattlesnake beds located near center of N.W.¼, sec. 30,

[1] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 16, p. 288, 1902.
[2] W. D. Matthew and H. J. Cook, Bull. Amer. Mus. Nat. Hist., vol. p. 368, 1909.

T. 12 S., R. 26 E., Willamette base line and meridian, Grant County, Oregon, approximately 5½ miles west of Dayville, and not over three-quarters of a mile south of type section of Rattlesnake formation.

Material available of type specimen includes $I\frac{2}{2}$, $I\frac{3}{3}$, superior and inferior canines, $P\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{2}{2}$, $M\frac{2}{2}$, an atlas, the greater part of humerus, half of ulna, metacarpal V, navicular, cuboid, metatarsal II, and several phalanges.

Dentition.—The incisors, canines, and $P\frac{1}{1}$ (figs. 11 and 12) approach in their characters the corresponding teeth in *Arctotherium*. The upper carnassial differs markedly from all specimens of *Ursus* and *Arctotherium* known to the writers, and approaches closely the type of $P\frac{4}{4}$ known in the several species of *Hyaenarctos*. In the Oregon spe-

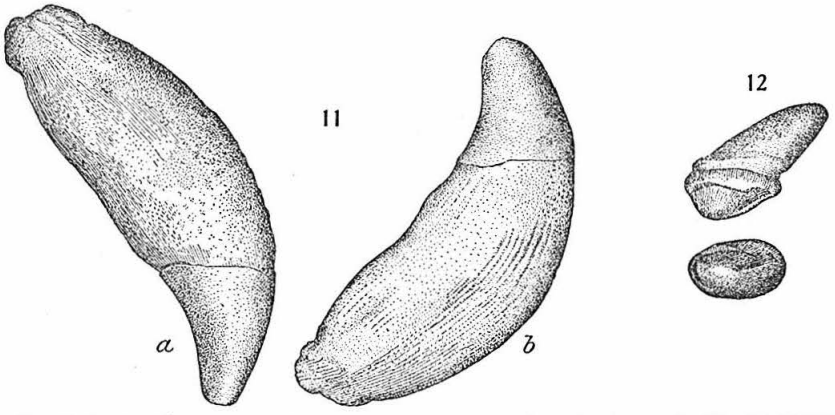


FIG. 11.—*Indarctos* (?) *oregonensis* Merriam, Stock, and Moody. Canine teeth, No. 22362 U.C.C. *a*, upper canine; *b*, lower canine; lateral views. ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

FIG. 12.—*Indarctos* (?) *oregonensis* Merriam, Stock, and Moody, $P\frac{1}{1}$., No. 22362 U.C.C.; inner and occlusal views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

cies the paracone is slightly larger than the metacone. The protocone is very large, approximating in its cross-section the size of the paracone, and is situated so far forward that its anterior border is not posterior to the corresponding border of the paracone as in *Ursus* and *Arctotherium*. A large parastyle is present. The tooth is distinctly three-rooted, a large and widely divergent root supporting the protocone. The outer contour of the tooth shows a distinct concavity of the cingulum opposite the posterior side of the paracone.

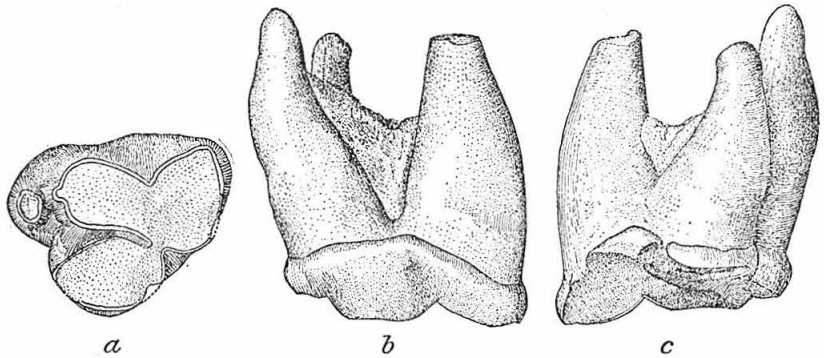


FIG. 13.—*Indarctos* (?) *oregonensis* Merriam, Stock, and Moody. $P\frac{4}{4}$, No. 22362 U.C.C. *a*, occlusal view; *b*, outer view; *c* inner view; ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

P4 (fig. 13) differs from the corresponding tooth of *Arctotherium* in the relatively large size of the protocone; in the support of the protocone upon a distinct, widely diverging inner or third root; in the situation of the protocone as far forward as the paracone; and in the presence of a large, distinctly separated parastyle. In all of the characters in which this tooth differs from *Arctotherium* it resembles *Hyaenarctos*.

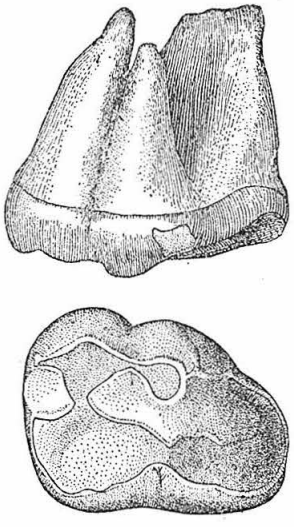


FIG. 14.—*Indarctos (?) oregonensis* Merriam, Stock, and Moody. M2, No. 22362 U.C.C.; occlusal and outer views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

M2 (fig. 14) of the bear from the Rattlesnake beds most nearly resembles that of the ursid type described by Pilgrim[1] from the middle or upper Siwalik beds of India under the name of *Indarctos salmontanus*. M2 of No. 22362 resembles the type of *I. salmontanus* in its unusual relation of width to antero-posterior diameter, and in the stage of development of the heel. The antero-posterior and transverse diameters are almost identical with those of the type of *I. salmontanus*. As in the Indian species, the paracone and metacone of No. 22362 are clearly defined, the paracone being considerably larger than the metacone. In No. 22362, as in *I. salmontanus*, there is evidence of a large tubercle immediately behind the antero-internal ridge, corresponding evidently to the hypocone. The extreme posterior end of the heel consists of a transverse ridge which is largely worn down.

Considering that in No. 22362 M2 is considerably worn, and allowing for individual variation, the resemblances between the Oregon specimen and the type of *I. salmontanus* are close. Small differences, such as the more distinctly circular cross-section of the metacone, the smaller hypocone, slightly longer heel, and wider trigon region in the Oregon form, suggest specific distinction such as would be expected in individuals so widely separated geographically.

The characters of M2 in the Oregon form and in *Indarctos salmontanus* approach those of *Hyaenarctos* except in relative elongation of the heel. The two outer cusps of M2 in *Hyaenarctos* may show somewhat stronger lateral compression than is noted in the Oregon form. The antero-internal ridge in *Hyaenarctos* may apparently show almost no separation into two divisions, or may be very distinctly divided as in *H. palaeindicus*, in which the hypocone region is imperfectly developed. In *H. punjabiensis* an incipient heel is clearly shown, though it is much less pronounced than in *Indarctos*.

M2 of the Rattlesnake specimen is distinguished from that of *Arctotherium* by its greater width and much shorter talon. In *Arctotherium* the primitive quadrituber-

[1] G. E. Pilgrim, Records, Geological Survey of India, vol. 44, pt. 3, pp. 225–233, pl. 20, 1914.

cular portion of the tooth is longer antero-posteriorly and the heel is much longer. The arrangement of the tubercles is much the same in the two types, but the tubercles show stronger lateral compression in *Arctotherium*.

The arrangement of the roots supporting $M\underline{2}$ in the Oregon specimen differs somewhat from that in *Arctotherium simum*. In No. 22362 there are two distinct external roots supporting the paracone and metacone regions. These roots in both available teeth are distinct, but are not widely separated. The inner and posterior region is supported by a large, broad root evidently composed of two parts, one of which supports the protocone region and the other originates above the hypocone and the region behind it.

In *Arctotherium* there are also evidently four original root elements, but the roots beneath the paracone and metacone tend to diverge widely, the element above the metacone being in some cases united with the posterior root supporting the heel. In *Arctotherium* the root supporting the protocone may or may not unite with the root above the heel.

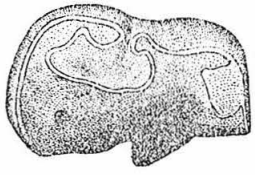


FIG. 15.—*Indarctos (?) oregonensis* Merriam, Stock, and Moody. $M\underline{2}$, No. 22362 U.C.C.; occlusal view. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

$M\underline{2}$ (fig. 15) is distinguished from the corresponding element in the dentition of *Hyaenarctos* and of certain forms of *Arctotherium* by the relative proportions of the trigonid and talonid regions. In the Oregon specimen the antero-posterior diameter of trigonid and talonid are, as nearly as can be determined, approximately equal. The tuberculation of $M\underline{2}$ represents only the inner side of the tooth, on which is shown the relatively high region occupied by the metaconid, and the lower more or less basin-like talonid region. The talonid possessed a rather wide hypoconid ridge, and two smaller cusps on the inner border as in *Hyaenarctos*. The crown of $M\underline{2}$ is supported upon two roots, of which the posterior is the larger.

Skeletal elements.—Perhaps the most characteristic element of the skeletal structures is the humerus (fig. 16). This specimen in No. 22362 is much more massive than the humerus of the California *Arctotherium*, and in this respect suggests the relatively heavy skeletal elements of *Hyaenarctos*. The humerus from the Rattlesnake beds resembles that of *Arctotherium* in the presence of an entepicondylar foramen.

The remaining skeletal elements belonging to No. 22362 from the Rattlesnake formation are, or tend to be, larger and heavier than the corresponding structures in *Arctotherium*.

Relationships.—The Oregon Pliocene bear approximates the characters of *Indarctos salmontanus* Pilgrim in the structure of $M\underline{2}$, the only available tooth representing that genus. The characters seen in the type of *Indarctos* and in the Oregon specimen are not found in other known forms. These characters are most nearly approached in $M\underline{2}$ of *Hyaenarctos*, *Arctotherium*, and *Aeluropus*, and are intermediate between those of *Hyaenarctos* and *Arctotherium*. In the characters of $P\underline{4}$ the Oregon specimen does not differ essentially from the several known species of *Hyaenarctos*, but is distinctly different from *Arctotherium*, *Aeluropus*, and all other known forms referred to the bear group.

The characters of the massive limb elements of the Oregon specimen suggest the limb type of *Hyaenarctos*, and indicate a rather wide separation from *Arctotherium*.

The sum of the known characters of the Oregon bear, specimen 22362, represent a type near *Hyaenarctos*, but tending toward *Arctotherium* in the development of its last upper molar. The *Indarctos* group is nearer to *Hyaenarctos* than to *Arctotherium*

and, as suggested by Pilgrim,[1] the discovery of a type intermediate between *Hyaenarctos punjabiensis* and *Indarctos salmontanus* might make it difficult to establish a generic separation between *Indarctos* and *Hyaenarctos*.

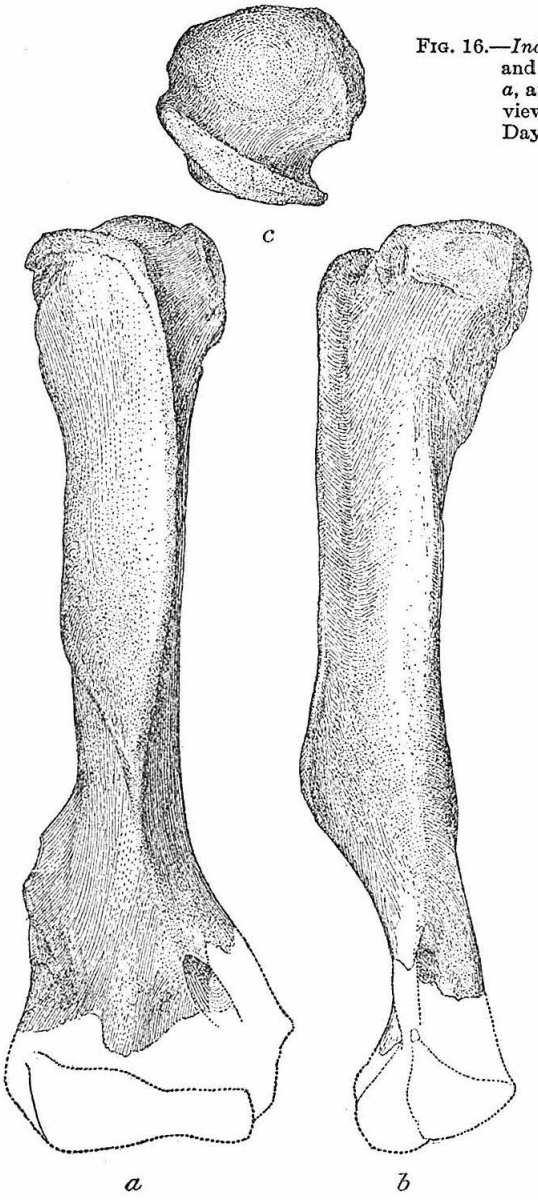


FIG. 16.—*Indarctos (?) oregonensis* Merriam, Stock, and Moody. Humerus, No. 22362 U.C.C.; *a*, anterior view; *b*, inner view; *c*, proximal view. ×0.25. Rattlesnake Pliocene, John Day Valley, Oregon.

Indarctos(?) sp.

A single upper carnassial, No. 22461 (fig.17), from U.C.C. locality 3042, represents an ursid type, differing slightly from the type specimen of *Indarctos(?) oregonensis*. This specimen was found resting upon beds of the Mascall Miocene, but was immediately below an occurrence of Rattlesnake Pliocene. No. 22461 agrees with the carnassial of the type specimen of *I.(?) oregonensis* approximately in its proportions, but differs in the smaller size of the tooth as a whole and in the relatively smaller parastyle of No. 22461. A large part of the protocone is broken away, but the root and a portion of this tubercle remaining indicate that the protocone was of large size.

Measurements (in millimeters) of $P\underline{4}$, No. 22461, are as follows: anteroposterior diameter, 26.7; transverse diameter across protocone (approximately), 19; antero-posterior diameter of paracone at base, 13; antero-posterior diameter of paracone along median line, 3.7.

This specimen differs from $P\underline{4}$ of the type of *I.(?) oregonensis* essentially in the somewhat smaller size of the proto ne and in the different form of the parastyle. Although the parastyle of No. 22461 has an antero-posterior diameter approximating that of the type specimen of *I. (?) oregonensis*, the parastyle in the latter is in reality heavier and probably of more distinctly conical form. Specimen 22461 presumably represents a

[1] G. E. Pilgrim, Records, Geol. Surv. India, vol. 44, pt. 3, p. 227, 1914.

different species and possibly a different genus from that of the type specimen of *I.* (*?*) *oregonensis*. It is tentatively to be referred to the Ursidae, and presumably represents either *Indarctos* or *Hyaenarctos*. A small portion of the maxillary in No. 22461 shows the alveolus of a P3, which is distinctly two-rooted. In this respect No. 22461 resembles certain forms of *Arctotherium*. *Hyaenarctos sivalensis* seems also to possess a two-rooted P3.

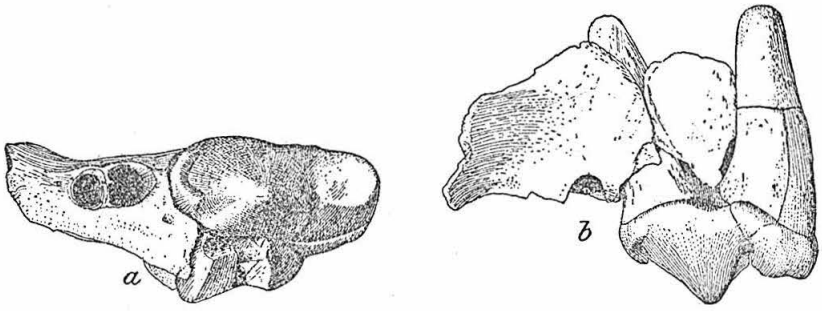


FIG. 17.—*Indarctos* (?) sp. P4, No. 22461 U.C.C.; *a*, occlusal view; *b*, outer view. ×1.0. Rattlesnake Pliocene, or Mascall Miocene, John Day Valley, Oregon.

P3 of *Hemicyon sansaniensis* is a large tooth which seems to have possessed two roots, although the writers have not been able to make certain of this character. In P4 of *Hemicyon sansaniensis* the protocone is very large, and there is evidently an incipient parastyle developing upon the cingulum. The protocone is smaller than in No. 22461, and the parastyle is also smaller, but there is a very suggestive resemblance.

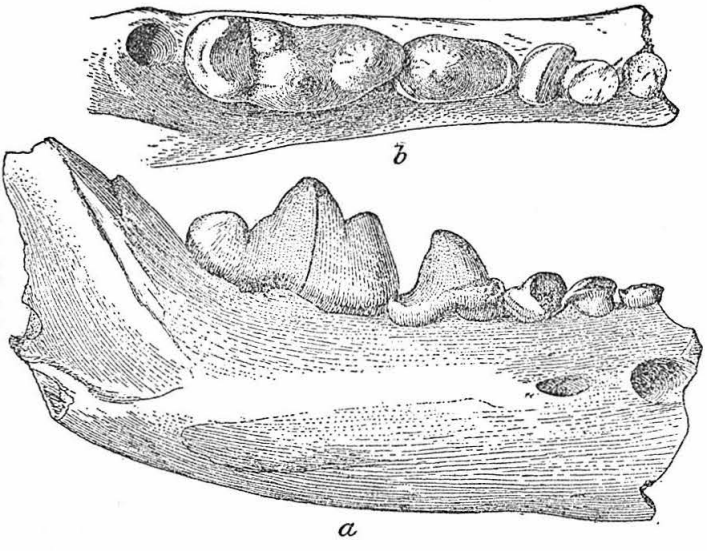


FIG. 18.—*Mustela* n. sp. Fragmentary ramus of mandible with teeth, No. 22463 U.C.C.; *a*, outer view; *b*, occlusal view. ×2.0. Rattlesnake Pliocene, John Day Valley, Oregon.

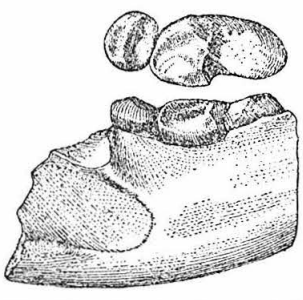
If No. 22461 is derived from the Mascall Miocene instead of from the Rattlesnake Pliocene its somewhat smaller size and slightly less specialized characters would probably be associated with other evidences of less-advanced stage of evolution than that of *Indarctos*(*?*) *oregonensis* of the Rattlesnake.

Mustela n. sp.

Lower jaw, No. 22463 (fig. 18), from U. C. locality 3045 in the Rattlesnake formation, represents a *Mustela* different from any previously described from the Pliocene deposits of the Great Basin region. This specimen consists of a portion of the right ramus of the mandible with $P\bar{4}$, $M\bar{1}$, the alveoli of the canine, with parts of $P\bar{2}$, $P\bar{3}$, and $M\bar{2}$. The first lower molar is of typical musteline form with a short wide heel on which the hypoconid is a well-developed ridge connecting with the lower eminence of the postero-internal region of the heel. The shearing blade is well developed. The metaconid is large.

The alveolus of $M\bar{2}$ represents the insertion of a single large root. $P\bar{4}$ has a well-developed heel, the posterior region of the protoconid is slightly worn, but the posterior cusp seems not to have been present. $P\bar{3}$ was two-rooted. The portion of the mandible available has dimensions twice those of the pine marten. Two mental foramina are present; one is situated near a point below the root of $P\bar{2}$, and the other below the posterior root of $P\bar{3}$.

A second small fragment of a musteline jaw, No. 22464 (fig. 19), represents a species but little more than half the size of that known by No. 22463. There is present only the worn posterior half of $M\bar{1}$ and the crown of $M\bar{2}$. This species is distinct from that represented by No. 22463.



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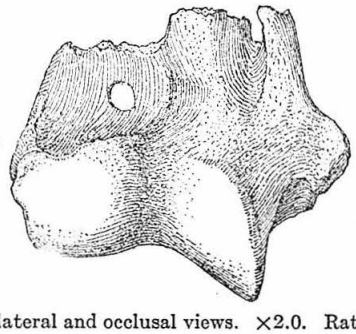

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FIG. 19.—Musteline jaw fragment, No. 22464 U.C.C.; lateral and occlusal views. ×2.0. Rattlesnake Pliocene, John Day Valley, Oregon.

FIG. 20.—Felid sp. *A*, large. Distal end of humerus, No. 309 U.C.C.; anterior view. ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

Measurements (in millimeters) of lower jaw, No. 22463.

Length of tooth series, $P\bar{2}$ to $M\bar{2}$ inclusive, alveolar measurement	34.4
$P\bar{4}$, antero-posterior diameter	8.1
$P\bar{4}$, greatest transverse diameter	4.3
$M\bar{1}$, antero-posterior diameter	13.8
$M\bar{1}$, greatest transverse diameter	5.6
$M\bar{1}$, transverse diameter of heel	5.2
Depth of mandible below anterior end of $M\bar{1}$	12
Thickness of mandible below middle of $M\bar{1}$	6.7

Felid sp. A, large.

A distal end of a humerus, No. 309, fig. 20, belonging to a felid form is slightly smaller than the corresponding part in *Smilodon*. In the Rattlesnake specimen the position of the entepicondyler foramen resembles that in the humerus of the lion more than that of the saber-tooth. The opening in *Smilodon* extends farther internally, reaching slightly beyond a vertical line drawn from the inner end of the distal trochlea and parallel to the main axis of the shaft. In *Felis* the foramen does not tend to reach beyond such a line. The Rattlesnake specimen resembles the true cats in this character.

Two specimens, a scaphoid-lunar and a phalangeal element (figs. 21 and 22), collected at U. C. locality 3060, are comparable in size to corresponding structures in *Smilodon*. The material may represent the same type of cat as that known by the fragment of the humerus, or may belong to a species or genus distinct from the latter

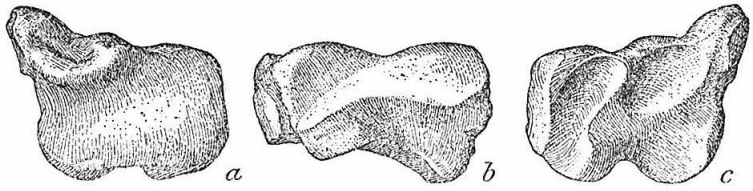


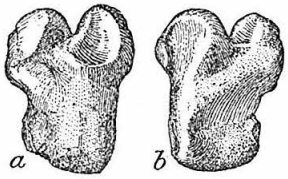
FIG. 21.—Felid sp. Scaphoid-lunar, No. 26786 U.C.C.; *a*, proximal view; *b*, anterior view; *c*, distal view. ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

Felid sp. B, small.

A distal end of a humerus, No. 23859, found at U. C. locality 3058, pertains to a cat much smaller than that represented by specimen 309 described above. It belongs to a form smaller than either *Felis daggetti* from the Pleistocene of Rancho La Brea or the Recent mountain lion of California.

RODENTIA.

A fragmentary ramus of the mandible, No. 26793, from University of California locality 3058, fig. 23, represents a squirrel type in the Rattlesnake fauna. The specimen was submitted to Dr. J. W. Gidley of the U. S. National Museum. Dr. Gidley has kindly furnished a description of the material and has concluded that it undoubtedly represents a new specific form. This statement is given below.



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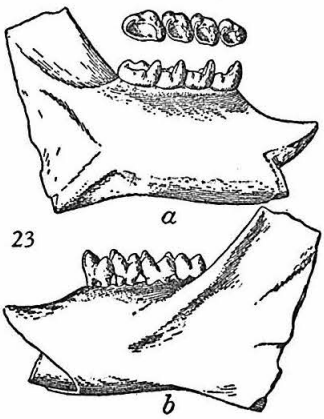

FIG. 22.—Felid sp. Phalangeal element, No. 26787 U.C.C.; *a*, dorsal view; *b*, ventral view. ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

FIG. 23.—*Otospermophilus gidleyi*, n. sp. Ramus of mandible, No. 26793 U. C. C.; *a*, inner view with occlusal view of teeth; *b*, outer view. ×2.0. Rattlesnake Pliocene, John Day Valley, Oregon.

We take pleasure in naming the species for Dr. Gidley.

Otospermophilus gidleyi n. sp.

This specimen from the Oregon Pliocene seems to represent a true *Citellus* in the broader meaning of the genus name. *Citellus*, however, has been split up into several genera or subgenera the characters of which are based mainly on skull modifications, and whose relative value is a matter of opinion. With only the material in hand therefore, there is some uncertainty regarding the exact position of the Pliocene species in reference to these minor groups. It is clearly distinguished from the other sciurids

by the combined characters of the relatively shorter anteroposterior extent of all the cheek teeth.

The dental characters are very similar to those of *Otospermophilus*, the group to which I would tentatively refer it. In common with the species of this group the cheek teeth are low crowned, with relatively little heightening of the trigonid portions, and in $P\overline{4}$ the two subequal cusps of the trigonid are closely appressed, making this tooth nearly triangular in outline. These characters are in contrast with the more highly specialized cheek teeth of true *Citellus*, in which the trigonid ridge of $P\overline{4}$ is widened almost as much as in the molars through the wider separation of these cusps, and this portion of all the molars is relatively much heightened. Comparing the fossil species with *O. adocetus* (No. 126120 U. S. Nat. Mus., Biol. Sur. Coll.), a species now living in Mexico, with which it agrees very nearly in size, and with the California species, *O. beecheyi* (No. 3559, U. S. Nat Mus., Biol. Sur. Coll.), about the only differences to be noted are as follows: In the fossil the talonid basins of all the lower cheek teeth are relatively somewhat shallower and definitely broader in area, the main outer cusps (protoconid and hypoconid) being slightly more marginal in position. The entoconids are almost completely obscured in the nearly continuous, relatively low, and evenly curved postero-internal rim of the talonid basins as in *O. beecheyi*. But the talonid rim is somewhat less elevated and the notch between the rim and the paraconid is less pronounced, being partially filled by a small intermediary cusp not observed or but rarely found in the living species. In *Citellus* and other sciurids in general this border is more or less angulate, and usually the entoconid, though small, is rather clearly defined. A character which seems to distinguish the fossil distinctly from the living species of the citellid group is the much greater relative depth and apparently shorter proportions of the lower jaw. This character and the more marginal position of the outer cusps are common to species of the more generalized types, and seem to indicate a somewhat less progressive stage of development of the fossil species as compared with the living citellids, although in some other respects it may be considered even more progressive than the living species, all of which suggest that the skull when known may present characters which would necessitate proposing a new subgroup for its reception. This step, in my opinion, however, is not warranted on what is presented in the type specimen.

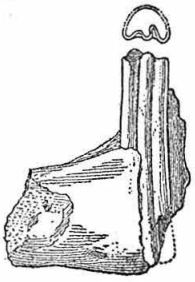

FIG. 24.—*Hypolagus*, near *vetus* (Kellogg). Mandibular fragment with $P\overline{3}$, No. 23174 U.C.C.; lateral view with view of occlusal surface of tooth. ×2.0. Rattlesnake Pliocene, John Day Valley, Oregon.

LAGOMORPHA.

Hypolagus, near vetus (Kellogg).

The rabbit remains from the Rattlesnake beds consist mainly of separate teeth and fragmentary limb elements. $P\overline{3}$ in the Oregon form resembles closely the corresponding tooth in the specimen from the Thousand Creek Pliocene referred to *Hypolagus vetus* by Dice.[1] No. 23174 (fig. 24), is slightly smaller than $P\overline{3}$ in the Thousand Creek specimen and the anterior re-entrant angle is a trifle deeper in the former tooth. On the whole, the enamel pattern in the tooth from the Rattlesnake approximates closely that in No. 12567 from Nevada.

[1] L. R. Dice, Systematic position of several American Tertiary Lagomorphs, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, pp. 181–182, 1917.

A number of upper cheek-teeth are preserved, one of which resembles very closely in size and shape No. 19799 from the Cedar Mountain beds, Stewart Valley Miocene of Nevada.

EDENTATA.

Megalonychid? gen. and sp. indet.

A single, fragmentary metapodial, No. 22900 (fig. 25), was collected at U. C. locality 3061 in the Rattlesnake beds. This specimen has been described by Stock,[1] and the following description and comparison can be quoted as follows:

"No. 22900 is short and stout. The lateral wall of the shaft is at right angles to that portion of the dorsal surface which still remains. It indicates that the metapodial possessed a relatively deep shaft and that the latter was presumably quadrilateral in section. The lateral facet for adjoining metapodial is flat and oval and is directed outward and downward. The proximal margin of this facet is not closely approached by the mesopodial surface, but this may be due in part to the worn condition of the specimen. The remaining portion of the mesopodial surface is but slightly concave transversely and does not reach the dorsal margin of the proximal end. Although an offset flanks the lower portion of the distal carina on one side, there was apparently not an extensive offset present on the opposite side.

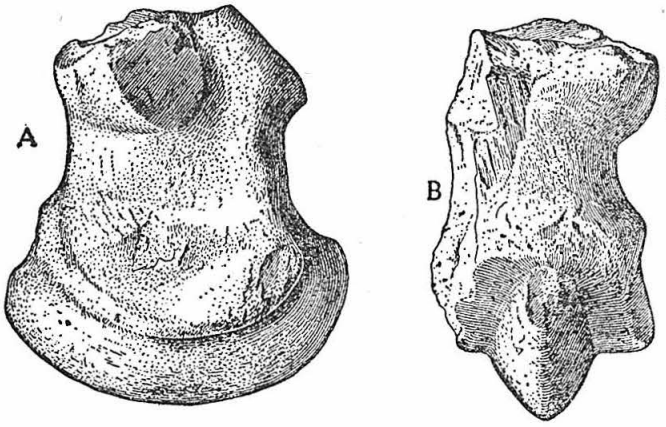

FIG. 25.—Megalonychid? gen. and sp. indet. Metapodial, No. 22900 U.C.C.; *A*, side view; *B*, dorsal view. × 1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

"The Rattlesnake specimen resembles the third metacarpal of *Hapalops* in quadrilateral cross-section of shaft. It differs, however, from this element in having a relatively shorter and deeper shaft. In *Hapalops* the proximal facet of the inner side is more extensive dorso-ventrally, is directed for the most part proximo-internally, and is of an entirely different shape than in No. 22900. The dorsal margin of the proximal end in the latter specimen was not deeply indented in middle line as in the Miocene form. The distal carina in *Hapalops* is slightly more prominent dorsally and the inner offset is also more extensive above than is the offset preserved in the Pliocene metapodial.

"Metacarpal III of *Megalonyx jeffersonii* is approximately twice as long as No. 22900 from the Pliocene. The shaft in the Pleistocene genus is relatively shorter than in *Hapalops*, but not as short as in the Rattlesnake specimen.

"With metatarsal II of *H. elongatus* certain differences and resemblances are to be noted. No. 22900 is relatively shorter and the shaft deeper; the lateral facet is small and flattened, while in *Hapalops* the facet for metatarsal I is relatively large and concave dorso-ventrally; the offset, which is preserved at the distal end, is less extensively developed. In the metatarsal of *Hapalops* (No. 15545 Princeton Univ. Coll.) under

[1] C. Stock, Carnegie Inst. Wash. Pub. No. 331, pp. 20–22, 1925.

observation, the lateral facet articulating with the first metapodial has much the same position and is directed downward in much the same manner as the facet in No. 22900. Below this facet in the Rattlesnake specimen there is some indication of a small knob or boss, as in the second metatarsal from the Santa Cruz beds. Dr. W. J. Sinclair, who has kindly examined a plaster cast of the Rattlesnake specimen, is of the opinion that it represents a second metatarsal and refers it to the right pes. He remarks that the proximal surface is flatter than in *Hapalops*, and in metatarsal II of the latter genus and of *Analcimorphus* this facet and the anterior (dorsal) surface meet in a markedly concave margin, which is not the case in the Pliocene form. If the specimen does represent the second metatarsal, then the inner facet is for the first metatarsal and the proximal surface for the mesocuneiform, as stated by Dr. Sinclair."

Comparative measurements (in millimeters).

	Length through middle.	Depth of distal carina.	Least depth of shaft.
No. 22900, Rattlesnake	[1] 52	46.8	30.3
Hapalops elongatus, metatarsal II, No. 15545, Santa Cruz	20.6	16.2	7.6
Analcimorphus sp.[2], metatarsal II, Santa Cruz	30.3	7.6	15

[1] Approximate. [2] Measurements taken by W. J. Sinclair.

PROBOSCIDEA.

Proboscidean Remains.

A number of fragments of cheek-teeth of mastodontine forms are known from the Rattlesnake, but as yet no specimens have been found which show characters sufficiently expressed to permit identification.

EQUIDAE.

Pliohippus spectans (Cope).

The type specimen of *Pliohippus spectans* described by Cope[1] consists of two upper cheek-teeth[2] listed from Cottonwood, Oregon, the type locality of both Mascall and Rattlesnake formations. The teeth came from a dirty grayish to reddish matrix having a closer resemblance to the characteristic Rattlesnake beds than to the Mascall. The well-authenticated occurrence of *Pliohippus* in place in the Rattlesnake formation and its absence from the Mascall collections taken with the suggested nature of the matrix on the type of *P. spectans* furnish almost conclusive evidence that this species is a Rattlesnake and not a Mascall form.

The species as described by Cope was characterized as possessing very wide fossettes with simple enamel borders, narrow crescents, and small columns. As has already been noted by other writers, this species is a typical member of the *Pliohippus* group as now defined. Its stage of development is near that of *P. interpolatus* of the Clarendon of Texas or of *P. fairbanksi* from the Ricardo Pliocene of the Mohave Desert.

A *Pliohippus* specimen, No. 22388 (fig. 26), from U. C. locality 3060 in the Rattlesnake, is evidently to be referred to *Pliohippus spectans*. No. 22388 includes a complete upper and lower cheek-tooth series. The large crowns of the upper teeth are heavily cemented and moderately curved. The fossettes are wide and show little crinkling of their enamel walls. The protocone of the premolars is very small, is nearly circular in

[1] E. D. Cope, Amer. Nat., vol. 14, p. 223, 1880.

[2] For figures of these teeth see H. F. Osborn, Mem. Amer. Mus. Nat. Hist., n.s., vol. 2, pt. 1, p. 165, fig. 132, 1918.

cross-section, and is set off from the protoconule by a sharp notch on the anterior side of the protoloph. In the posterior molars the protocone is somewhat flattened and curved backward toward the hypocone. The characters of the protocone of the premolars resemble those in *P. interpolatus* and *P. fairbanksi*, but the sum of the characters of M1 and M2 is closely similar to that in the type molar tooth of *P. spectans*. The species as represented by the present material shows resemblance to *P. interpolatus* but is somewhat smaller. Unfortunately material is not available for comparison with the posterior cheek-teeth of that species. *P. fairbanksi* of the Ricardo Pliocene is also a similar form though distinguished by narrower fossettes. Unfortunately the posterior cheek-teeth of *P. fairbanksi* have not yet been described.

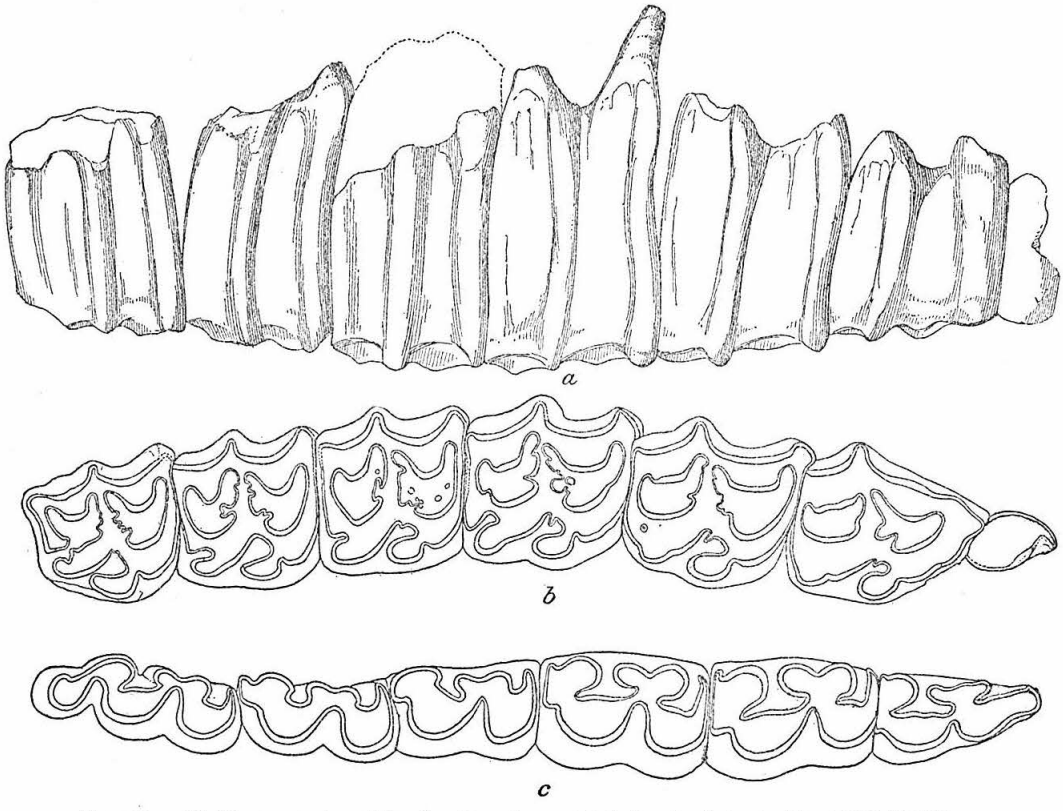

FIG. 26.—*Pliohippus spectans* (Cope). Superior and inferior cheek-teeth, No. 22388 U.C.C.; *a*, outer view; P1 to M3 inclusive; *b*, occlusal view, P1 to M3 inclusive; *c*, occlusal view, P2 to M3 inclusive. × 0.75 (approximate.) Rattlesnake Pliocene, John Day Valley, Oregon.

A large functional P1 is present in the dentition of No. 22388.

The lower cheek-tooth series of *P. spectans* as represented in No. 22388 (fig. 26*c*) shows the premolars much wider and heavier than the molars, the difference between the occlusal areas of premolar and molar regions being very marked. The metaconid-metastylid column is short and the inner groove narrow. In the molars the parastylid extends toward the median side as far as the inner border of the metaconid-metastylid column, but in the premolars it falls short of reaching this plane. The antero-internal angle of the entoconid approaches a right angle. The outer walls of protoconid and hypoconid are strongly convex.

A series of somewhat worn cheek-teeth (fig. 27), representing *Pliohippus*, show characters near those of No. 22388 and presumably belong to *P. spectans*. In No. 22391 the crowns are slightly smaller than in No. 22388, and show a slightly greater wear. In this specimen the protocone is united posteriorly with the hypocone. This character may be diagnostic of a group distinct from that represented by No. 22388 or it may be due merely to advanced wear.

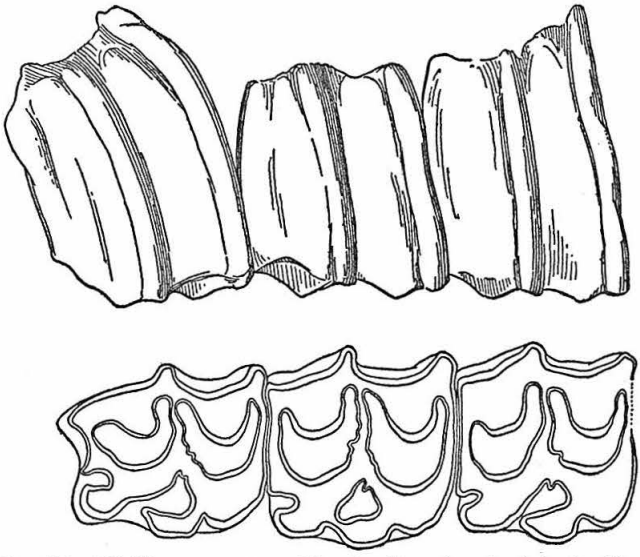

FIG. 27.—*Pliohippus spectans* (Cope). Superior cheek-teeth, No. 22391 U.C.C.; outer and occlusal views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

A number of scattered incisor teeth found with *Pliohippus* specimens show large crowns with deep cement-filled pits. These teeth are presumably in some part to be referred to *P. spectans*.

Measurements (in millimeters) of dentition, No. 22388.

Length of tooth-row from anterior end of $P\underline{1}$ to posterior end of $M\underline{3}$	173.8	$M\underline{3}$, transverse diameter	22
		Length of tooth-row from anterior end of $P\overline{2}$ to posterior end of $M\overline{3}$	165.1
$P\underline{1}$, antero-posterior diameter	14.5	$P\overline{2}$, antero-posterior diameter	29
$P\underline{1}$, transverse diameter	9.4	$P\overline{2}$, transverse diameter	13
$P\underline{2}$, antero-posterior diameter	31.5	$P\overline{3}$, antero-posterior diameter	27.4
$P\underline{2}$, transverse diameter	24	$P\overline{3}$, transverse diameter	15.5
$P\underline{3}$, antero-posterior diameter	29.2	$P\overline{4}$, antero-posterior diameter	28.4
$P\underline{3}$, transverse diameter	26.2	$P\overline{4}$, transverse diameter	14
$P\underline{4}$, antero-posterior diameter	29.2	$M\overline{1}$, antero-posterior diameter	24.7
$P\underline{4}$, transverse diameter	26.5	$M\overline{1}$, transverse diameter	12.5
$M\underline{1}$, antero-posterior diameter	26	$M\overline{2}$, antero-posterior diameter	26.2
$M\underline{1}$, transverse diameter	26.8	$M\overline{2}$, transverse diameter	11.4
$M\underline{2}$, antero-posterior diameter	25.3	$M\overline{3}$, antero-posterior diameter	31.7
$M\underline{2}$, transverse diameter	24.6	$M\overline{3}$, transverse diameter	10
$M\underline{3}$, antero-posterior diameter	27.2		

MILK DENTITION OF PLIOHIPPUS.

Several upper milk teeth of *Pliohippus* (fig. 28), from the Rattlesnake beds have heavily cemented subhypsodont crowns. The enamel bordering the fossettes shows only moderate folding. The protocone is small and flattened or crescent-shaped in the

little-worn teeth. In a worn Dm$\underline{3}$, No. 2193 (fig. 28*a*), the protocone is nearly circular in cross-section. These teeth are larger than any milk teeth of the *Pliohippus* type known thus far from the Ricardo Pliocene.

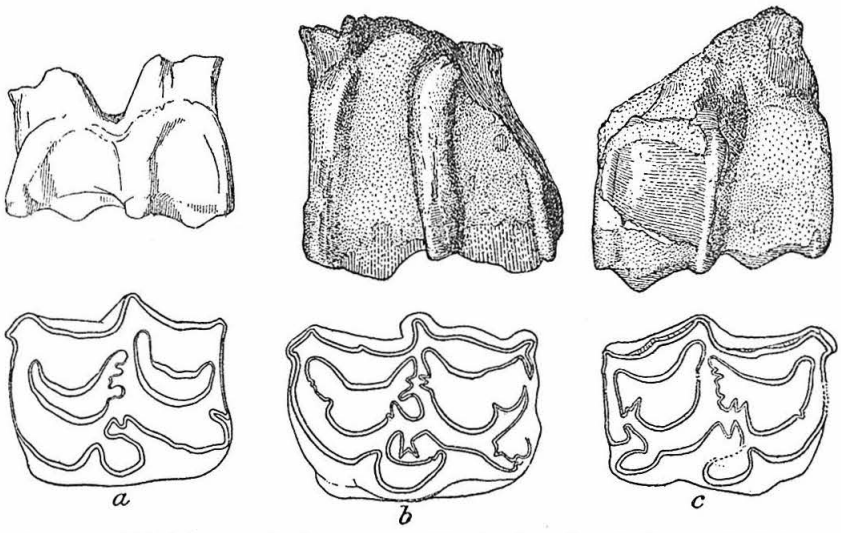

FIG. 28.—*Pliohippus*, probably *spectans* (Cope). Superior deciduous cheek-teeth, lateral and occlusal views; *a*, Dm $\underline{3}$, No. 2193 U.C.C.; *b*, No. 26791 U.C.C.; *c*, No. 22392 U.C.C. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

The lower cheek-teeth of the milk dentition of *Pliohippus* forms from the Rattlesnake are represented in several specimens. These teeth are heavily cemented and short-hypsodont. The metaconid-metastylid column is narrower transversely, and its inner groove somewhat wider than in the permanent premolars of forms known from this horizon. In Dm$\overline{2}$ the entoconid is often truncated obliquely at the anterior end more as in *Merychippus* than is the case in permanent P$\overline{2}$ of this species. As shown in No. 22393 (fig. 29), Dm$\overline{2}$ may have an antero-external fold on the parastylid and a small fold on the inner side of the hypoconid.

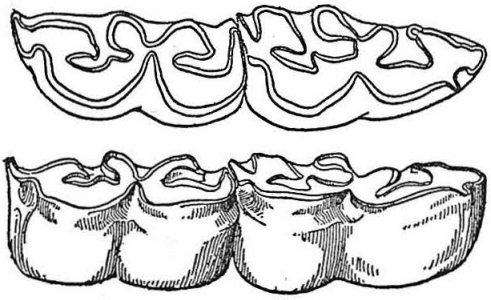

FIG. 29.—*Pliohippus*, probably *spectans* (Cope) Dm$\overline{2}$ and Dm$\overline{3}$, No. 22393 U.C.C.; occlusal and outer views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

Measurements (in millimeters) of milk dentition, No. 22395.

Dm$\overline{2}$, antero-posterior diameter..... 34.1	Dm$\overline{3}$, greatest transverse diameter.... 13.3
Dm$\overline{2}$, greatest transverse diameter.... 12.7	Dm$\overline{4}$, antero-posterior diameter..... 32.7
Dm$\overline{3}$, antero-posterior diameter..... 30.8	Dm$\overline{4}$, greatest transverse diameter.... 12.6

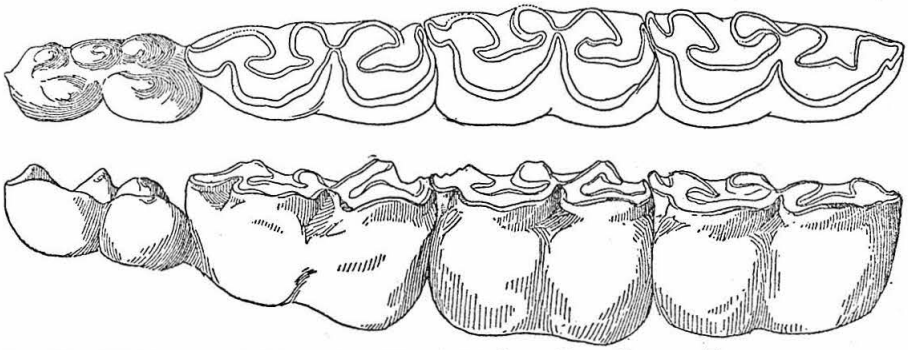

FIG. 30.—*Pliohippus*, probably *spectans* (Cope). $Dm\bar{2}$, $Dm\bar{3}$, $Dm\bar{4}$, and $M\bar{1}$, No. 22395 U.C.C.; occlusal and outer views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

EQUID LIMB ELEMENTS.

An anterior and a posterior equid metapodial from the Rattlesnake represent horses having approximately the size of the larger horses of the Ricardo Pliocene. Metatarsal III (fig. 31*c*), was secured at locality 3060 in association with the cheek-

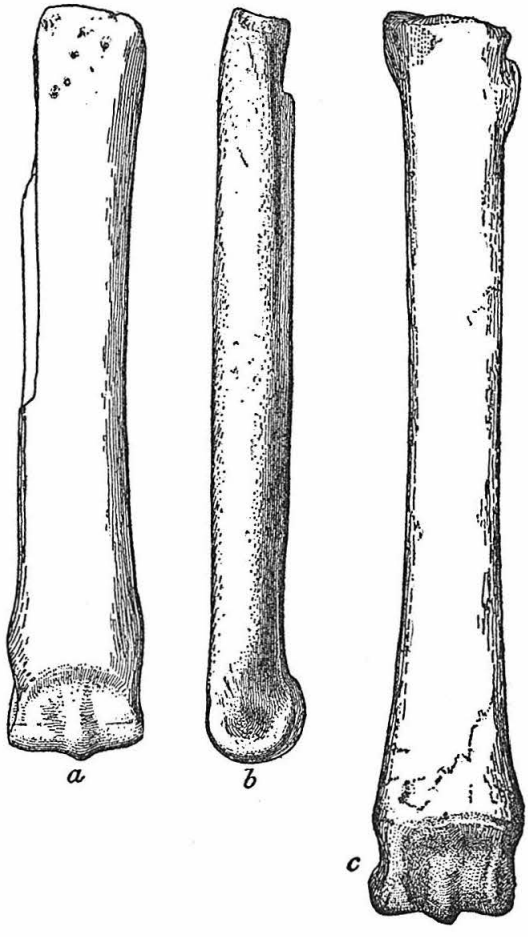

FIG. 31.—Equid limb elements. Metacarpal III, No. 2230 U.C.C.; *a*, anterior view; *b*, side view; *c*, metatarsal III, No. 22425 U.C.C. anterior view. ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

teeth of *Pliohippus spectans*, and the metapodial belongs presumably to this species. On both the front and hind metapodials the distal keel is strongly developed on the anterior side of the distal articular face. The shaft is much less slender than in *Hipparion whitneyi* and approaches rather the proportions in *Pliohippus*. The facets of the proximal end are not shown.

Measurements (in millimeters) of metapodials.

	Metacarpal III No. 2230.	Metatarsal III No. 22425.
Greatest length (approximate)	196.8	238.5
Width of shaft immediately below middle	28	25.1
Greatest antero-posterior diameter of shaft at middle	20.3	25.2
Width of distal articulating surface (approximate)	34.6	37.1

Hipparion sinclairi (Wortman).

The type of this species was described from Cottonwood Creek in the John Day region of Oregon. The original specimen was obtained within the limits of the typical area of the Mascall Miocene and of the Rattlesnake Pliocene, and was found in the loose gravels above the Mascall. There is therefore good reason for considering the occurrence of this species as in the Rattlesnake formation.

The type specimen described by Wortman[1] is an upper cheek-tooth, possibly $P\frac{4}{}$, No. 8178 Amer. Mus. Coll. The species is described as showing characters in general similar to those of *Hipparion occidentale*, but separated from that form by smaller size and "less marked concavity of the antero-internal lobe."

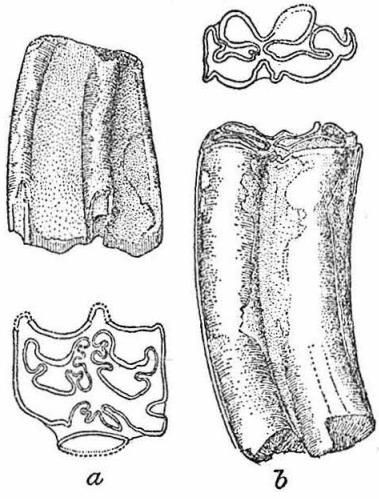

FIG. 32.—*Hipparion sinclairi* (Wortman). Upper and lower cheek-tooth; *a*, $M\frac{1}{}$? No. 22363 U.C.C.; outer and occlusal views; *b*, lower molar, No. 22381 U.C.C.; outer and occlusal views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

Gidley[2] called attention to the fact that *H. sinclairi* is larger than *H. montezumae* and differs from that species in its relatively larger and differently formed protocone, and more simple enamel plications. Gidley also noted that the protocone is concave on the inner face as in *H. affine*.

[1] For figures of this specimen see H. F. Osborn, Mem. Amer. Mus. Nat. Hist., n.s., vol. 2, pt. 1, p. 196, fig. 159, 1918.
J. L. Wortman, Kansas City Rev. Sci. and Industry, vol. 6, No. 2, p. 73, 1882.

[2] J. W. Gidley, Bull. Amer. Mus. Nat. Hist., vol. 23, p. 900, 1907.

An upper cheek-tooth (M1?) No. 22363 (fig. 32*a*), from U. C. locality 3068 in the Rattlesnake beds corresponds approximately in form and dimensions to the type of *H. sinclairi*, and evidently represents that species. This tooth has dimensions of the crown near those of *Hipparion gratum*, but it differs from that species in the much greater antero-posterior diameter and lateral compression of the protocone. In the character of the protocone it resembles *Hipparion molle* from the Jacalitos portion of the Etchegoin Pliocene on the western border of the San Joaquin Valley, and *H. montezumae* from the later Tertiary beds of Lacualtipan, Hidalgo, Mexico. The Rattlesnake specimen is, however, considerably wider transversely than the known material of *H. molle*. The protocone of the type of *H. montezumae* is sh orter antero-posteriorly than in No. 22363 and the fossettes seem narrower.

Specimen 22363 resembles *H. sinclairi* in the character of the fossettes and in the extreme compression of the protocone. The protocone is, however, more strongly compressed in No. 22363.

Comparative measurements (in millimeters) of upper teeth.

	Hipparion sinclairi, type P4?	Hipparion sinclairi No. 22363 M1?	Hipparion molle, type M3.
Antero-posterior diameter	20.3	20	*a* 19.3
Transverse diameter	19	20	*a* 15.8
Antero-posterior diameter of protocone	8.7	9.9	9.4
Height of crown	42.3	....	48

a Approximate.

As the only material certainly determined as *H. molle* consists of three upper molars it is possible that additional collections will show a closer connection between *H. sinclairi*, *H. montezumae*, and *H. molle*. Whether or not these forms represent the same species it is worthy of note that they all seem to occur at a horizon near early Pliocene.

Two small lower cheek-teeth, No. 22381 (fig. 32*b*) and No. 22382, were associated with the upper tooth referred to *Hipparion sinclairi*. These specimens have dimensions such as might be expected in lower teeth of *H. sinclairi*. They are much smaller than a number of lower cheek-teeth which approximate the size of *H. occidentale*, and are evidently specifically distinct from the larger form. There seems good ground for determination of these specimens as *H. sinclairi*, of which the lower teeth have not been known up to this time. The two lower teeth referred to *H. sinclairi* are of closely comparable dimensions and are almost identical in form. They resemble the posterior premolars of certain of the more advanced protohippine horses in the extent to which the inner border of the metastylid projects beyond the entoconid on the median side, but the backward curvature of the crowns suggests a molar tooth. As is indicated in figure 32*b*, the metaconid-metastylid column is long antero-posteriorly, and the valleys anterior and posterior to this column are very narrow. The antero-internal side of the entoconid is filled out and not obliquely truncated as in *Merychippus*. There is an antero-external ridge on the protoconid and a small but well-developed fold appears also on the antero-external wall of the hypoconid.

Measurements (in millimeters) of lower teeth.

	No. 22381.	No. 22382.
Antero-posterior diameter	21	21.8
Transverse diameter	10.2	10
Antero-posterior diameter of metaconid-metastylid column	13.1	14.1

Hipparion occidentale Leidy.

This species is reported from beds in the John Day Valley in eastern Oregon by W. D. Matthew.[1] According to J. L. Wortman, the specimens reported by Matthew were collected from the Rattlesnake beds overlying the Mascall at Cottonwood Creek in the John Day Valley.

Two upper cheek-teeth, No. 26788 and No. 26789 (figs. 33, *a* and *b*), obtained at U. C. locality 3057, represent a *Hipparion* species larger than *H. sinclairi* and having a much smaller protocone. In many characters these teeth closely approach *Hipparion mohavense* of the Ricardo Pliocene. There is, however, a tendency to flattening of the protocone beyond the normal stage seen in the Ricardo species. The Rattlesnake

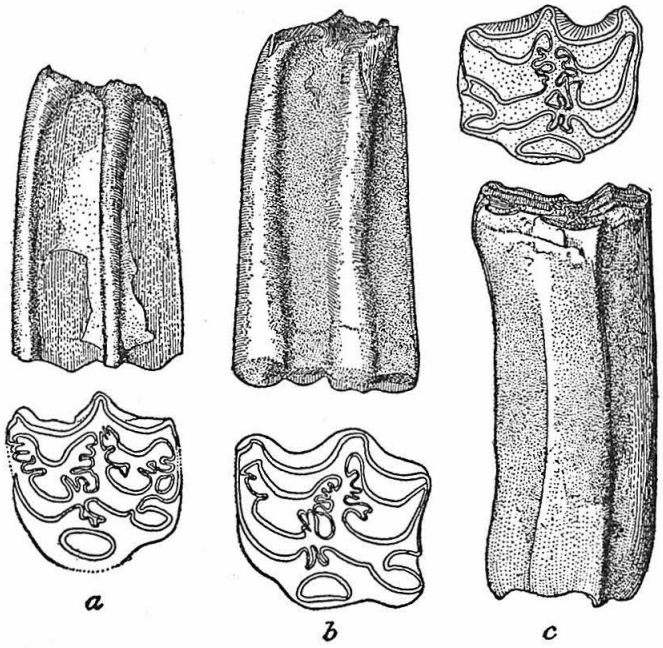

FIG. 33.—*Hipparion occidentale* Leidy. Upper cheek-teeth; *a*, No. 26788 U.C.C.; lateral and occlusal views; *b*, No. 26789 U.C.C.; lateral and occlusal views; *c*, No. 957 U. C. C.; inner and occlusal views. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

species seems also to show a slightly stronger mesostyle and somewhat different folds in the enamel surrounding the fossettes. The characters of these Rattlesnake specimens seem well within the range of variation of *Hipparion occidentale* as at present known, and the writers hesitate to separate them from the Great Plains species.

A single cheek-tooth, No. 957 (fig. 33*c*), collected in the John Day region by a University of California party in 1900, shows characters near those of *Hipparion occidentale*. This specimen was found at locality 887, which was considered in the field to represent mainly Rattlesnake Pliocene. In the area in which collections were made at this locality Rattlesnake beds cap hills which are formed in part of Mascall Miocene. As yet no specimen of this nature is certainly known from the Mascall exposures. No. 957 approaches one form of *Hipparion occidentale* in size, in form of protocone, and in complication of the enamel bordering the posterior ends of the fossettes. The anterior border of the prefossette is without folds in No. 957, and the general appearance of the borders of the fossettes is one of relative simplicity. This tooth resembles *H. sinclairi* to some extent in the tendency toward simplicity of the enamel folds and in the form of the protocone, but the differences in pattern are considerable. *H. sinclairi* also differs from No. 957 in its considerably smaller size. It is possible that more

[1] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 12, p. 70, 1899.

material will show that the form of tooth seen in No. 957 grades into that of typical *H. sinclairi*. With existing material it appears to represent a distinct and larger species resembling in many respects one form of the Great Plains *H. occidentale*.

Comparative measurements (in millimeters) of teeth.

	No. 957.	Hipparion occidentale, type.	Hipparion sinclairi, type.	Hipparion sinclairi, No. 22363 $M\underline{1}$?
$M\underline{2}$, antero-posterior diameter	23.5	23	20.3	20
$M\underline{2}$, transverse diameter	20.1	22	19	20
$M\underline{2}$, antero-posterior diameter of protocone	8.8	....	8.7	9.9
$M\underline{2}$, height of crown	56.2	....	42.3	....

Hipparion leptode Merriam or Hipparion occidentale Leidy.

Specimen No. 544 (fig. 34), consisting of three lower cheek-teeth of a large *Hipparion*, was collected by the 1900 party at locality 884 in the region of Rattlesnake Creek west of the Mascall ranch near Dayville, Oregon. These teeth came from an area in which both Rattlesnake and Mascall beds were exposed, but the reddish matrix showing in places on the teeth indicates quite certainly their derivation from the reddish or brownish tuffs of the Rattlesnake which here rests upon the white Mascall strata.

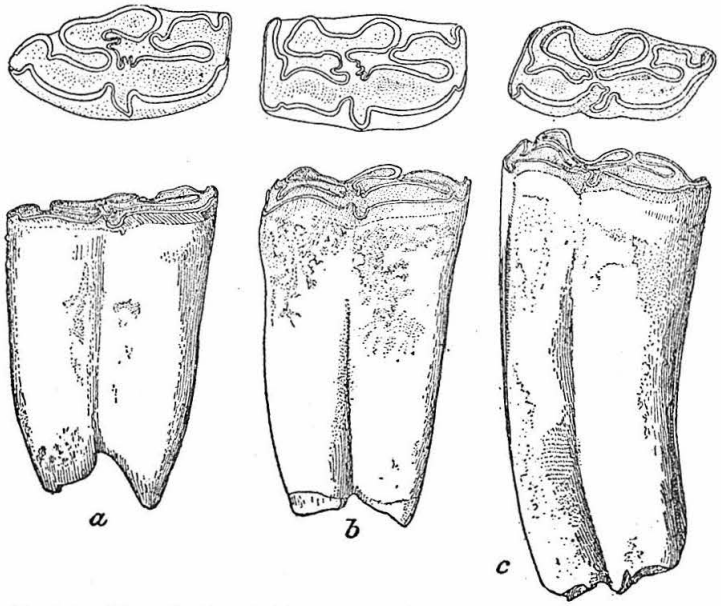

FIG. 34.—*Hipparion leptode* Merriam or *Hipparion occidentale* Leidy. Lower cheek-teeth, No. 544 U.C.C.; outer and occlusal views; *a*, $P\overline{2}$; *b*, $M\overline{1}$; *c*, $M\overline{2}$. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

$M\overline{2}$ of the Rattlesnake specimen (No. 544) resembles the peculiar *Hipparion leptode* from Thousand Creek in many characters. An antero-external ridge is present and strongly developed on the protoconid and the hypoconid in both forms. The metaconid-metastylid column is long and deeply grooved externally in both. The external groove is somewhat more acute at the inner end in the Rattlesnake specimen, but this

may be due to difference in wear. The Rattlesnake specimen is somewhat shorter antero-posteriorly, and is a little less compressed laterally than the Thousand Creek type.

$P\bar{2}$ and $M\bar{1}$ of No. 544 resemble $M\bar{2}$ in the presence of the strong antero-external ridge on the hypoconid. $P\bar{2}$ and $M\bar{1}$ differ from the Ricardo forms in the strength of the ridge on the hypoconid. The ridge may be present in the Ricardo specimens, but is very much weaker. In $M\bar{1}$ the metaconid-metastylid column seems to show slightly more compression in the Rattlesnake specimen than in the forms from the Ricardo Pliocene. The crowns in No. 544 seem to be slightly larger. The cement covering is heavier.

This form appears specifically distinct from the Ricardo species and perhaps also from the specimen known from Thousand Creek. It is evidently allied to the latter, as also to a form from the Neohipparion (Hipparion) zone of the North Coalinga region. This species is very close to *Hipparion occidentale* and is not improbably to be referred to that species.

In the collection from the Rattlesnake region of eastern Oregon there is a single lower cheek-tooth, No. 2220, with a rather short, much compressed crown showing in general a close resemblance to *Hipparion leptode* from Thousand Creek. The heavily cemented crown is not greatly worn. It shows more compression than in the Thousand Creek specimen, but is scarcely more than 30 mm. in length, whereas the somewhat worn Thousand Creek specimen evidently reached 70 mm. in length when unworn. It is to be presumed that tooth No. 2220 is a milk molar of the *Hipparion* type like the type of *H. leptode* from Thousand Creek or possibly represents the milk dentition of *H. occidentale*.

Comparative measurements (in millimeters) of teeth.

	No. 544, Rattlesnake.	Hipparion leptode, type No. 19414, Thousand Creek.
$P\bar{2}$, antero-posterior diameter	27.2	....
$P\bar{2}$, transverse diameter	13.2	....
$M\bar{1}$, antero-posterior diameter	26.7	....
$M\bar{1}$, transverse diameter	12.9	....
$M\bar{1}$, antero-posterior diameter of metaconid-metastylid column	15.8	....
$M\bar{2}$, antero-posterior diameter	25.9	29 plus
$M\bar{2}$, transverse diameter	10.5	11
$M\bar{2}$, anteroposterior diameter of metaconid-metastylid column	14.4	14.6
$M\bar{2}$, greatest length of crown	57.5 (worn)	66

Hipparion anthonyi Merriam.

A very fragmentary specimen consisting of parts of several upper cheek-teeth from U. C. locality 3062 in the Rattlesnake beds represents a *Hipparion* of approximately the size seen in *Hipparion occidentale*. This specimen, No. 22386 (fig. 35, *a* and *b*), differs from those referred to *H. occidentale* in that the enamel folds bordering the fossettes are more numerous, more closely appressed, and sharper. The protocone is comparatively short antero-posteriorly, and approaches a circular cross-section a little more closely in the protocone of *H. occidentale*. As specimen 22386 represents an individual in which the crowns are worn well toward the base, the character of the enamel folds bordering the fossettes has considerable significance, as the folds tend generally to simplify toward the base of the tooth. The shortness of the crown coupled with complexity of enamel folds might be interpreted as indicating that these teeth represent the milk dentition, but the crown is, as far as can be determined, much wider

than in the milk teeth of *Hipparion*. This species is possibly related to *Hipparion mohavense* of the Ricardo Pliocene or it may represent the upper dentition of *Hipparion anthonyi* of the Ironside region across the Blue Mountains to the southeast of the John Day Valley.

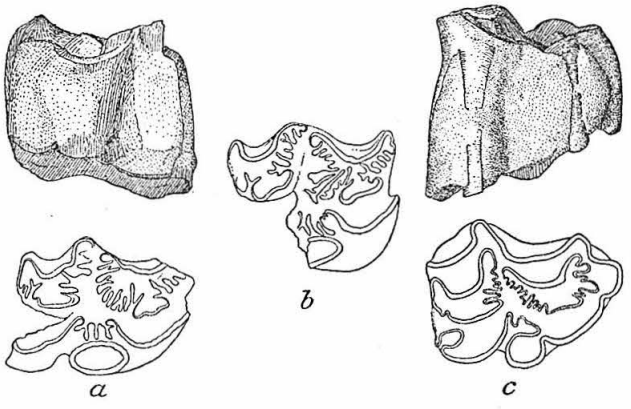

FIG. 35.—*Hipparion anthonyi* Merriam. Upper cheek-teeth; lateral and occlusal views; *a* and *b*, No. 22386 U.C.C.; *c*, No. 22362 U.C.C. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

A second individual, No. 22362 (fig. 35c), found with the specimen of *Indarctos (?) oregonensis* at locality 3058, consists of a single permanent P2, worn down close to the base of the crown. The circular protocone is lightly connected with the protoconule. In spite of the stage of wear, the enamel bordering the fossettes shows very numerous, strongly marked folds. This tooth, which clearly represents the permanent dentition, resembles those of No. 22386 in the extreme complication of the enamel folds in a section of the crown near the base and in the short antero-posterior diameter of the protocone. It probably represents the same species as No. 22386.

RHINOCEROTIDAE.

?Teleoceras, near fossiger (Cope).

Remains of rhinoceroses from the Rattlesnake deposits consist of several teeth and include a very fragmentary portion of a mandible in which milk teeth are being replaced by the permanent set. In addition to these specimens there is also available some skeletal material, comprising, among other elements, a lunar, a third metacarpal and metatarsal, and several calcanei.

Specimen 23177, fig. 36*a*, an unworn tooth from locality 3060, represents presumably either P2 or Dm2. The Oregon specimen bears some resemblance in shape to P2, as figured by Leidy and Lucas[1] for *Teleoceras fossiger* from Florida, but it is slightly larger. Although the crochet and anticrochet are well developed in No. 23177, there is no union between them and this separation exists to the base. Two cristae are developed, the anterior of which is the more prominent one. They are closely situated and remain disconnected throughout their length, with each other and with the crochet.

No. 23177 resembles Dm2 closely in size and in presence of the two cristae, but in the specimens of this tooth figured by Leidy and Lucas[2] the cristae have united with adjoining structures inclosing two small enamel lakes.

M3, No. 23175 (fig. 36*b*) from the Rattlesnake, is smaller but more worn than the corresponding tooth of *T. fossiger* from Florida, as figured by Leidy and Lucas. In the Rattlesnake specimen the anterior transverse crest is more simple than in the tooth from Florida and the anticrochet is represented by a convexity only. The crochet is, however, well developed. The paracone and parastyle are separated by an open groove which extends the entire height of the crown, thus differing from the Florida

[1] Trans. Wagner Free Inst. Sci., vol. 4, pl. 8, fig. 7, 1896.
[2] *Op. cit.*, pl. 8, figs. 5 and 13, 1896.

specimen in which such separation is absent. The hypocone in the tooth from Oregon is conical and is separated by a shallow notch from the remaining portion of the metaloph.

The Rattlesnake specimen, when compared with the corresponding tooth in No. 22420, a skull of *Teleoceras fossiger* from the Republican River beds of Kansas, is seen to be much smaller. There is a very distinct anticrochet developed, but the crochet is rather small in M3 of the Kansan form. The tooth from Oregon differs also from the latter in decided separation of parastyle and paracone.

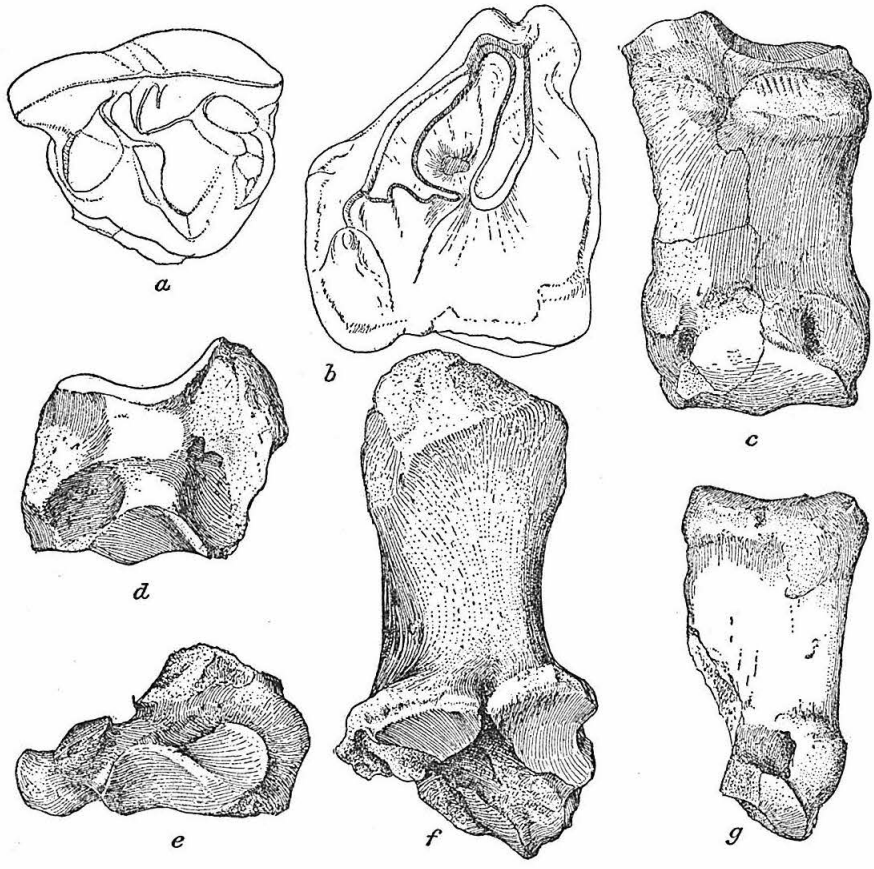

FIG. 36.—?*Teleoceras*, near *fossiger* (Cope). Teeth and skeletal elements; *a*, P2 or Dm2, No. 23177 U.C.C.; occlusal view; ×1.0. *b*, M3, No. 23175 U.C.C.; occlusal view; ×1.0. *c*, metacarpal III, No. 23181 U.C.C.; anterior view; ×0.50. *d*, scaphoid, No. 23860 U.C.C.; antero-internal view; ×0.50.; *e*, lunar, No. 23178, ×0.50. *f*, calcaneum, No. 23179 U.C.C.; ×0.50; *g*, metatarsal III, No. 23182 U.C.C.; anterior view; ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

The degree of brachypedy in the Rattlesnake form is comparable to that of *T. fossiger* from the Republican River beds, and there is close similarity between the Oregon and Kansan individuals, not only in the metapodials (figs. 36*c* and *g*) but in other elements of the foot as well. The calcaneum (fig. 36*f*) possesses the long posterior projection characteristic of *T. fossiger*. At the articular end the transverse width in all specimens available decidedly exceeds the antero-posterior diameter.

The rhinoceros known from locality 3068 by a left lunar, No. 23178, fig. 36*e*, and a right scaphoid, No. 23860, fig. 36*d*, was somewhat larger than the adult specimen of

T. fossiger, No. 22552, from the Republican River and in the collections of the Museum of Palaeontology, University of California.

Measurements (in millimeters) of dentition.

P2 or Dm2, No. 23177, greatest antero-posterior diameter	38.5
P2 or Dm2, No. 23177, greatest transverse diameter	33.2
M3, No. 23175, antero-posterior diameter along inner side	45.7
M3, No. 23175, transverse diameter along anterior crest	52.7

Measurements (in millimeters) of foot elements.

Lunar, No. 23178:		
Greatest antero-posterior diameter		88.9
Width (approximate)		43
Dorso-ventral diameter		54.1
Metacarpal III, No. 23181:		
Greatest length		121.9
Width of proximal end		73.5
Width of distal end		67.5
Calcaneum:	No. 23179	No. 23180
Total length	152.1	....
Antero-posterior diameter of articular end	56.2	65.7
Transverse diameter of articular end	....	86.2
Metatarsal III, No. 23182:		
Greatest length (approximate)		103
Transverse diameter of proximal end		55.2
Antero-posterior diameter of proximal end		41.

SUIDAE.

Prosthennops ? sp.

Most of the material pertaining to the peccary was collected at locality 3060 in Rattlesnake gravels and tuffs, and consists of fragmentary parts of jaws and of the dentition. Among the incomplete series of teeth secured there are very often deciduous molars, thus indicating, seemingly, that the band of peccaries whose remains accumulated at locality 3060 consisted of many relatively young individuals.

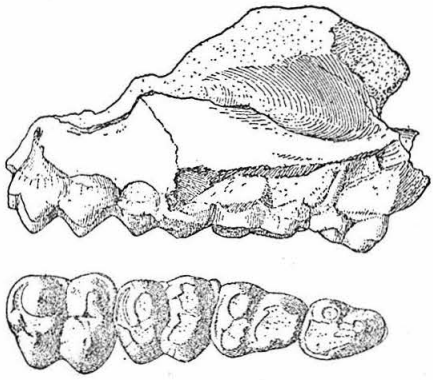

FIG. 37.—*Prosthennops?* sp. Fragment of maxillary with teeth, No. 23862 U.C.C.; lateral and occlusal views; ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

A fragmentary specimen of the right maxillary, No. 23862 (fig. 37), bears three deciduous molars and the first permanent molar. The milk teeth are much worn. The two anterior teeth of the deciduous set have not become molariform, a character which has been acquired, however, by the third tooth. The former teeth resemble corresponding teeth in *Platygonus*. Dm2 and Dm3 possess each a single cusp on the anterior half and two cusps arranged in transverse row on the posterior half of the tooth. In the type of *Prosthennops crassigenis* the teeth are greatly worn and adequate

comparison can not be made therefore between M1 of the Rattlesnake specimen and the corresponding tooth in Gidley's species. The facial pit of the maxillary, situated above the deciduous teeth, is deeply formed in No. 23862.

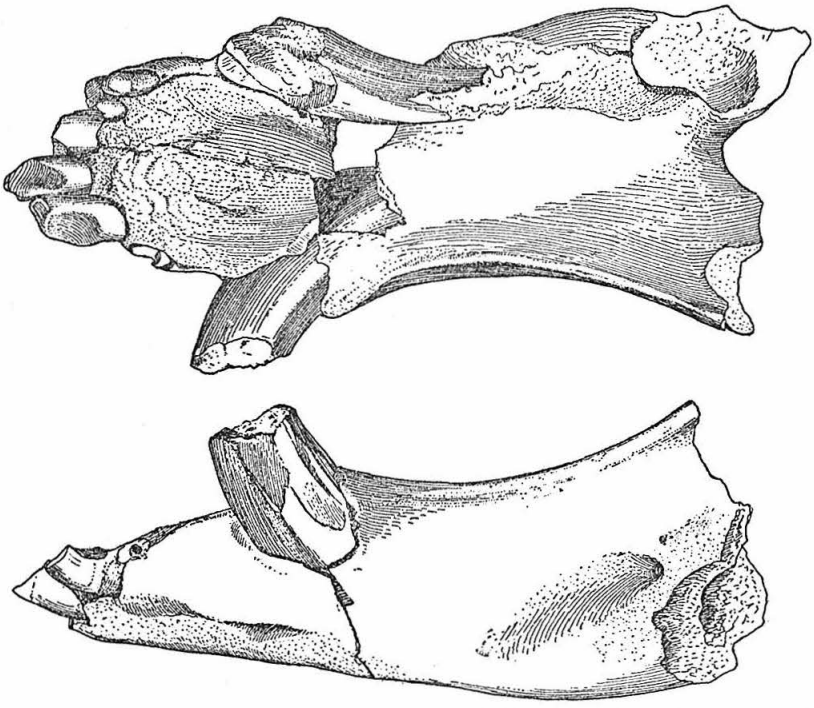

FIG. 38.—*Prosthennops?* sp. Symphyseal part of mandible, No. 22861 U.C.C.; dorsal and lateral views; ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

A symphyseal part of a mandible, No. 23861 (fig. 38), does not possess the canine and incisor teeth in a good state of preservation. In this specimen three incisors are present in each ramus, the medial two well developed and the lateral one rudimentary. The diastema between $I\bar{3}$ and the canine is much longer than in *Tayassu*. The diastema behind the canine is also long, having an extent equivalent to that in *Platygonus*. It is fully as long, if not longer, than that in the Snake Creek specimen, determined by Matthew and Cook[1] as *Prosthennops* cf. *crassigenis*. Two mental foramina are present, one below the anterior border of the canine and near the symphyseal line, the other below and toward the end of the diastema. There is no ventral keel in No. 23861.

The inferior canine in the Rattlesnake species, No. 23868, is of triangular outline with outer face slightly convex, inner face flattened, and posterior face slightly concave. This tooth when unworn shows a distinct recurvature at the tip.

$M\bar{1}$ and $M\bar{2}$ in specimen 23863 (fig. 39*a*), are close in size to corresponding teeth in the fragmentary ramus of the mandible from the Snake Creek beds referred provisionally by Matthew and Cook to *Prosthennops* and compared with the species *crassigenis*. The lower jaw as represented by the fragment from the Rattlesnake compares favorably in size with the Snake Creek material, but the former belongs to a younger individual. A distinct but shallow groove exists along the inner side and above the

[1] W. D. Matthew and H. J. Cook, Bull. Amer. Mus. Nat. Hist., vol. 26, pp. 389–391, fig. 13. 1909.

lower border of the Oregon specimen as in the Recent *Tayassu*. $M\bar{1}$ in No. 23863 is smaller than the corresponding tooth in the jaw from the Snake Creek beds referred by Matthew[1] to *Prosthennops serus*, slightly more so in antero-posterior diameter,

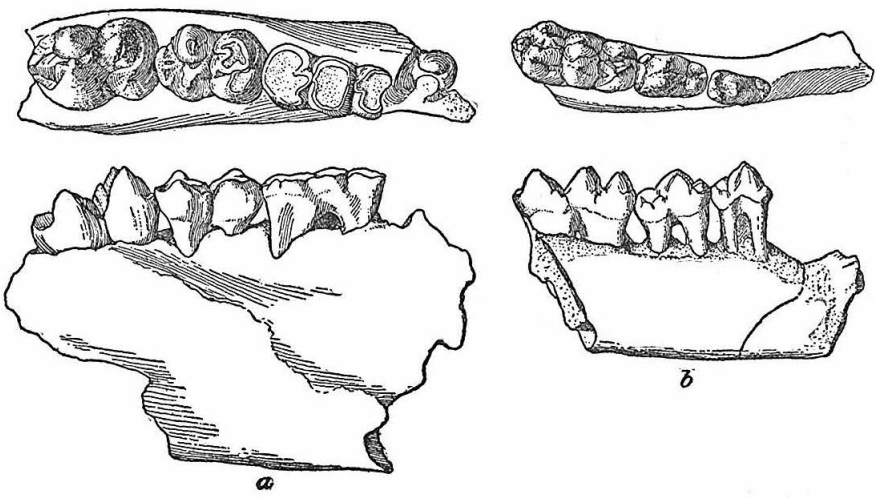

FIG. 39.—*Prosthennops* sp. Mandibular fragments with teeth; lateral and occlusal views; *a*, No. 23863 U.C.C., functional teeth include $Dm\bar{4}$, $M\bar{1}$, and $M\bar{2}$; *b*, No. 23864 U.C.C., $Dm\bar{2}$, $Dm\bar{3}$, and $Dm\bar{4}$. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

decidedly more so in transverse diameter. $M\bar{2}$ is of same length but decidedly narrower transversely than the corresponding tooth in the Snake Creek species, *P. serus*. The occlusal pattern of the two teeth of No. 23863 and that of the teeth of *P. serus* seem fairly close, but in the Oregon form the cusps are slightly higher.

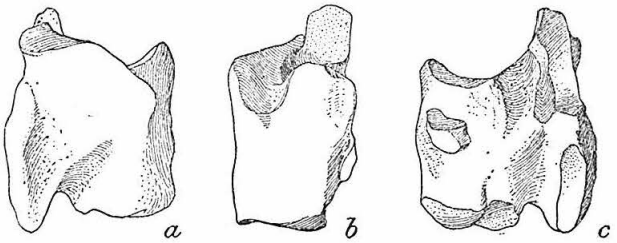

FIG. 40.—*Prosthennops?* sp. Cuboid, No. 23865 U. C.C.; *a*, anterior view; *b*, outer view; *c*, inner view. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

Peccaries appear to have been better represented in the Rattlesnake fauna than in the Pliocene assemblage of mammals found in the Thousand Creek beds of Nevada. The symphyseal fragment described by Merriam[2] from the latter deposits resembles No. 23861 from the Rattlesnake in possessing the full complement of incisor teeth. The differences which distinguish the Thousand Creek form are very slight and rest in (1) greater width anterior to canine teeth, (2) larger $I\bar{3}$, (3) shorter interspace between alveoli for $I\bar{3}$ and canine, and (4) larger anterior mental foramen.

[1] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 38, pp. 214-215, fig. 15, 1918.
[2] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 6, pp. 272–275, fig. 54, 1911.

Measurements (in millimeters) of material referred to Prosthennops? sp.

No. 23862:	
Length of tooth series, $Dm\underline{1}$ to $M\underline{1}$ inclusive	49.8
$Dm\underline{2}$, antero-posterior diameter	10
$Dm\underline{2}$, greatest transverse diameter	7.4
$Dm\underline{3}$, antero-posterior diameter	12.7
$Dm\underline{3}$, greatest transverse diameter	9.7
$Dm\underline{4}$, antero-posterior diameter	12.8
$Dm\underline{4}$, greatest transverse diameter across anterior half	11.2
$M\underline{1}$, antero-posterior diameter	14
$M\underline{1}$, greatest transverse diameter across anterior half	12
No. 23863 (possibly same individual as No. 23862):	
$Dm\bar{4}$, antero-posterior diameter	17.9
$Dm\bar{4}$, transverse diameter posteriorly	9.3
$M\bar{1}$, antero-posterior diameter	16.6
$M\bar{1}$, transverse diameter posteriorly	11
$M\bar{2}$, antero-posterior diameter	18.3
$M\bar{2}$, transverse diameter posteriorly	12.8
Depth of lower jaw between $M\bar{1}$ and $M\bar{2}$ measured normal to tooth row	34.2
Thickness of lower jaw below $M\bar{1}$	17.4
No. 23864:	
Length of lower deciduous series ($Dm\bar{1}$ to $Dm\bar{3}$ inclusive)	37.8
$Dm\bar{2}$, antero-posterior diameter	9
$Dm\bar{2}$, transverse diameter posteriorly	4.8
$Dm\bar{3}$, antero-posterior diameter	10.7
$Dm\bar{3}$, transverse diameter posteriorly	6.2
$Dm\bar{4}$, antero-posterior diametor	18.3
$Dm\bar{4}$, transverse diameter posteriorly	8.8
No. 23867:	
Superior canine, antero-posterior diameter at base of crown (approximate)	13.3
Superior canine, transverse diameter at base of crown	7.3
Superior canine, length of crown measured along anterior border	27.5
No. 23866:	
Inferior canine, antero-posterior diameter at base of crown	13
Inferior canine, transverse diameter at base of crown	8
No. 23861:	
Length of symphysis of mandible in horizontal line	86.9
Width of symphyseal part of mandible anterior to alveoli for canine teeth	29
Vertical depth of symphysis at posterior end	20.3
Length of diastema between alveoli for $1\bar{3}$ and canine	8.3
Right cuboid, No. 23865:	
Antero-posterior diameter	22.5
Transverse width anteriorly	16
Proximo-distal diameter anteriorly	21.3

?Platygonus rex Marsh.

A very large peccary has been described by Professor Marsh[1] from three molar teeth of large size obtained from deposits presumed to be Pliocene occurring in eastern Oregon. L. S. Davis, who was employed by Professor Marsh as collector in the John Day region, recalls securing what he believes to be the type specimen of this species in the Rattlesnake gravels of the type area.

According to Marsh[1] the peculiar characters of *Platygonus rex* are found in its large size, and in the fact that the crowns of the cheek-teeth are composed of well-rounded conical tubercles, few in number. The figures of the type specimen published by Marsh represent a form in which the crowns of the cheek-teeth exhibit a simplicity of the tubercles. In these teeth no transverse ridges or lophs are formed.

Marsh's species presumably represents a form in or near *Prosthennops*. In certain characters it verges towards *Mylohyus*, but in this second genus intermediate tubercles are developed to a much greater extent than in Marsh's species from the Rattlesnake.

[1] O. C. Marsh, Amer. Jour. Sci., ser. 3, vol. 48, p. 273, 1894.

J. W. Gidley[1] has compared *Platygonus texanus* with *P. rex* and indicates differences. As to the age of the latter form Gidley states: "Marsh gives the horizon as Pliocene, but it is almost certainly Upper Miocene."

Of the various dicotyline forms known in the Tertiary of the Pacific Coast and Great Basin provinces the one most closely resembling the type of Marsh's *Platygonus rex* is that represented by two lower molar teeth from the Etchegoin formation[2] on the western border of the Great Valley of California. Specimen 21360 of the upper Etchegoin fauna shows dimensions and form closely similar to M$\overline{3}$ of Marsh's type of *Platygonus rex*. It is doubtful whether the two forms are specifically identical, but they appear to be closely related.

Comparative measurements (in millimeters).

	Platygonus rex.	No. 21360, Etchegoin formation.
M$\overline{3}$, greatest antero-posterior diameter	27.4	27.2
M$\overline{3}$, transverse diameter	16	15.9

CAMELIDAE.

Although some parts of the dentition are available, the greater portion of the camel material from the Rattlesnake beds consists of skeletal elements. Practically all the remains are to be referred to the larger types, such as perhaps would be represented by *Pliauchenia* and *Alticamelus*.

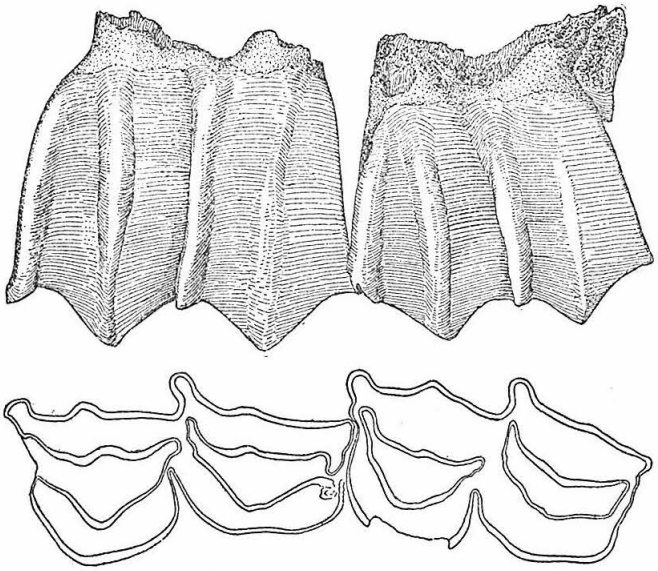

FIG. 41.—*Pliauchenia ?* or *Alticamelus?* sp. M$\underline{1}$ and M$\underline{2}$, No. 23857. U.C.C.; lateral and occlusal views; ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

Several upper and lower molar teeth are available. At locality 3068 M$\underline{1}$ and M$\underline{2}$ were found associated together with a lower molar, and presumably the three teeth belong to the same individual, No. 23857. In the upper teeth (fig. 41) the anterior

[1] J. W. Gidley, Bull. Amer. Mus. Nat. Hist., vol. 19, p. 479, footnote, 1903.
[2] J. C. Merriam, Trans. Amer. Philos. Soc., vol. 22, pt. 3, p. 36, figs. 40*a* and 40*b*, 1915.

lobe, particularly that in M2, is decidedly ridged externally. The following measurements (in millimeters) of these teeth have been taken at the base of the crown:

Length from anterior end of M1 to posterior end M2	68.4
M1, antero-posterior diameter	32.7
M1, transverse diameter through posterior lobe	30.4
M2, antero-posterior diameter	38.3
M2, transverse diameter through anterior lobe	33
Lower molar, antero-posterior diameter	36.1
Lower molar, transverse diameter	26.3

A somewhat smaller and less worn molar tooth, No. 23856, from the type locality of the Rattlesnake, has the ridges on the outer walls of paracone and metacone even more prominently developed than in No. 23857. The measurements in millimeters of this specimen are: M2?, antero-posterior diameter at base of crown, 37.4; M2?, transverse diameter through anterior lobe, 27.

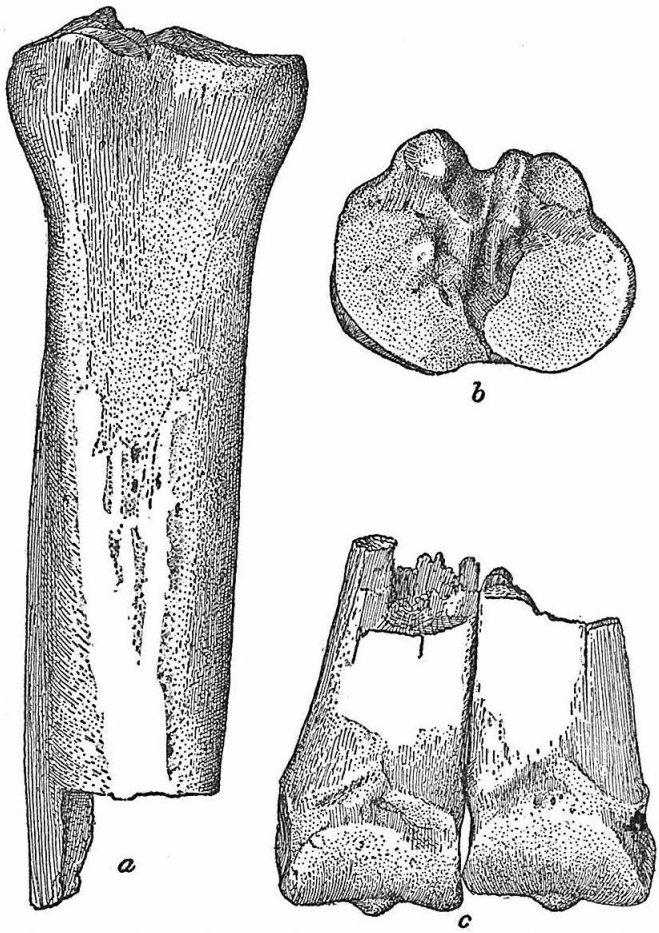

FIG. 42.—*Pliauchenia?* or *Alticamelus?* sp. Cannon bones; *a*, posterior cannon bone, No. 23853 U.C.C.; anterior view; *b*, No. 23853 U.C.C.; proximal view; *c*, No. 26790 U.C.C.; anterior view. ×0.50. Rattlesnake Pliocene, John Day Valley, Oregon.

Limb elements.—A cannon bone of the posterior limb is preserved by a considerable part of the proximal half and is comparable in size to the largest of the posterior meta-

podials from Ricardo and referred tentatively to *Pliauchenia* or *Alticamelus*. This specimen, No. 23853, is shown in figure 42, *a* and *b*.

There are at least two types of astragali belonging to the camels, one of which, No. 23854, is similar in size and shape to specimens from the Ricardo Pliocene that have been referred tentatively to *Alticamelus*. A second type of astragalus is apparently indicated by specimen 23861 which is somewhat smaller than No. 23854 and may be tentatively determined as belonging to *Pliauchenia* or *Alticamelus*.

The sustentacular portion of a calcaneum, No. 23858, from the Rattlesnake deposits is of same size as that in specimen No. 21567 from the Ricardo beds, referred to *Alticamelus* or *Pliauchenia?*.

Proximal phalanges have not been found as abundantly in the Rattlesnake beds as in the Ricardo deposits. The best preserved phalanx approximates in size specimens from the Ricardo.

Comparative measurements (in millimeters) of limb elements.

	Rattlesnake, No. 23853	Ricardo, No. 23118
Posterior cannon bone:		
Width of proximal end	80	81.6
Greatest antero-posterior diameter of proximal end	64.4	63
	Rattlesnake, No. 23855	**Ricardo, No. 21567**
Calcaneum:		
Depth of sustentaculum	81.6	83.5
Width at base of tuber calcis	58.7	59

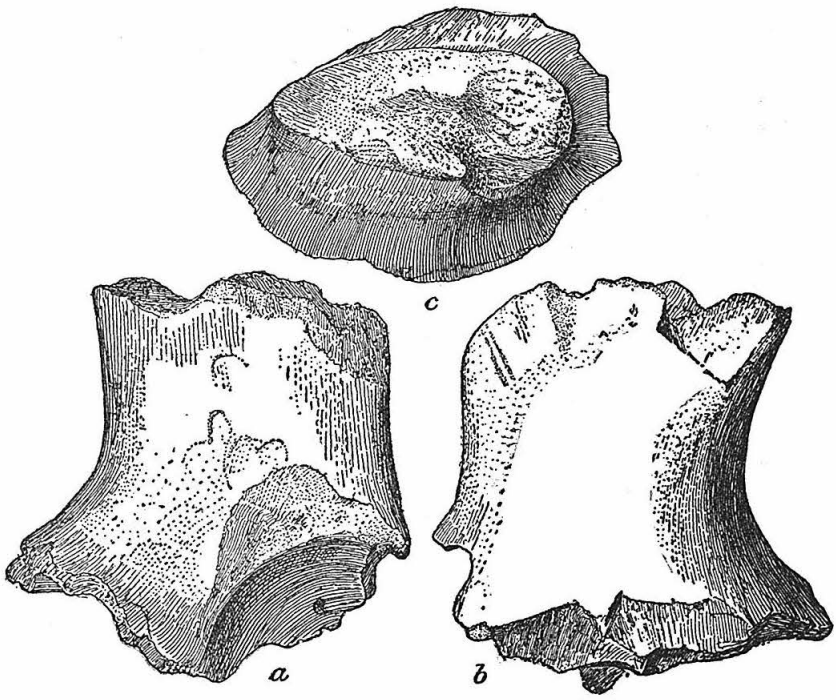

FIG. 43.—*Sphenophalos* sp. Horn-core, No. 22428 U.C.C.; *a*, outer view; *b*, inner view; *c*, dorsal view. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

BOVIDAE.

Sphenophalos sp.

Specimen 22428, found by the 1916 expedition at U. C. locality 3045 in the Rattlesnake formation, represents the basal portion of the horn-core and the posterior-superior region of the orbit of an antelope of the *Sphenophalos* type (fig. 43). In cross-section of the horn-core, No. 22428 is not identical with any of the few specimens of adult *Sphenophalos* from Thousand Creek, but its form falls well within the limits of variation of the Thousand Creek material. While it is not possible to demonstrate that this Rattlesnake specimen is to be referred to the Thousand Creek species, it is evidently a form closely related to it, if it is not identical with it. This is the only known occurrence of a horn-core of any of the several types of Thousand Creek antelopes outside the limits of the typical Thousand Creek beds.

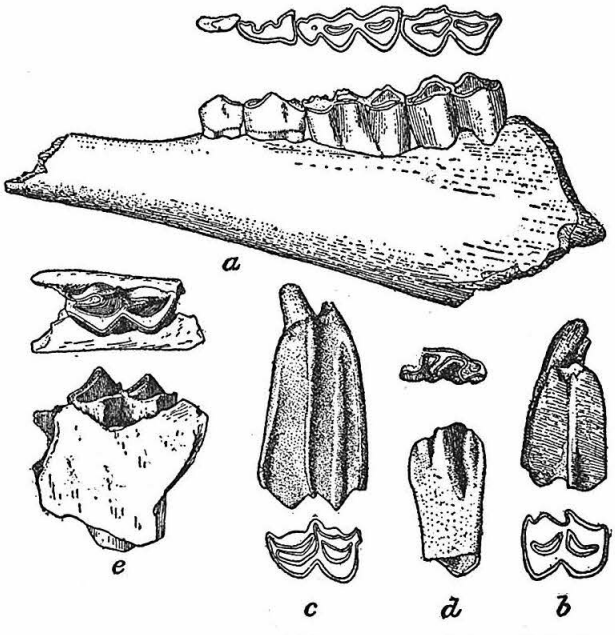

FIG. 44.—*Ilingoceros* or *Sphenophalos?* sp. Fragment of lower jaw and teeth; *a*, jaw with deciduous teeth and $M\bar{1}$, No. 22426 U. C. C.; *b*, upper molar, No. 22435 U.C.C.; *c*, upper molar, No. 22433 U.C.C.; *d*, $P\bar{4}$ or $P\bar{3}$, No. 22446 U. C. C.; *e*, lower molar, No. 22445 U.C.C. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

Ilingoceros or Sphenophalos? sp.

Several specimens of skeletal elements and teeth from the Rattlesnake represent antelope forms approaching some of the Thousand Creek types referred to *Ilingoceros* and *Sphenophalos*. With the scanty material available it is difficult to make an exact determination.

An astragalus, No. 22434 (fig. 45*d*), from locality 3057, associated with an antelope upper cheek-tooth, has the size and the peculiarities of form characterizing small Thousand Creek antelope astragali referred to *Sphenophalos* or *Ilingoceros*, possibly representing the first of these two genera. In this specimen there is a well-developed flange below the inner trochlear ridge and the posterior end of this ridge terminates in a marked inferior process extending almost at right angles to the antero-posterior plane of the astragalus. The inner trochlear articular surface which extends out upon this inferior process does not bend around beneath the astragalus sufficiently far to turn forward inferiorly as it does in *Antilocapra*. Both the character of this inner flange and that of the posterior process described are distinctive characters of Thousand Creek antelopes. Among the Thousand Creek forms there are two types of astragali: a larger and somewhat wider form in which the flange below the inner side of the trochlea is

low, and a smaller narrower type with less pronounced inner flange. The former is possibly to be associated with the large *Sphenophalos* or *Ilingoceros* and the latter with the small *Ilingoceros* or a small form (No. 22430) presumed to lead to *Sphenophalos*. In both of these types the characteristic peculiar process below the inner posterior end of the inner trochlear ridge is present. Specimen 22434 presumably represents the larger of the two Thousand Creek forms. The measurements in millimeters of No. 22434 are as follows: Greatest length, 34.5; greatest width, 21.9.

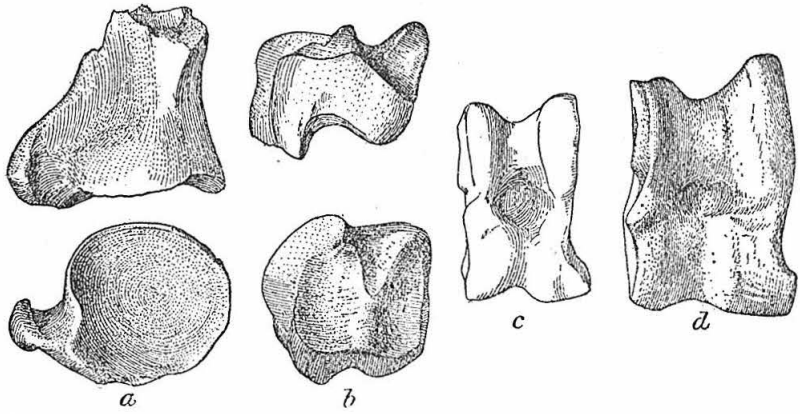

FIG. 45.—*Ilingoceros* or *Sphenophalos?* sp. Skeletal elements; *a*, fragment of scapula, No. 22432 U.C.C.; *b*, naviculo-cuboid, No. 22436 U.C.C.; *c*, astragalus, No. 22443 U.C.C.; *d*, astragalus, No. 22434 U.C.C. ×1.0. Rattlesnake Pliocene, John Day Valley, Oregon.

An astragalus, No. 22443 (fig. 45*c*), from locality 3045, is much smaller than specimen 22434 and is also narrower transversely. It is of approximately the same size as numerous antelope astragali of the smaller and narrower Thousand Creek type, presumably representing one of the small species of *Ilingoceros* or possibly a small form of *Sphenophalos*. This specimen is slightly narrower than the small Thousand Creek form, but the difference may not indicate more than a specific separation. Small antelope astragali from the Orinda-Pinole Tuff Pliocene at Pinole, California, closely approach the Rattlesnake specimen 22443 in size, and resemble this form in being relatively narrow. In narrowness the Pinole forms may even exceed the Rattlesnake specimen. The measurements in millimeters of astragalus, No. 22443, are as follows: Greatest length, 27; greatest width, 16.9.

The distal end of a small scapula, No. 22432 (fig. 45*a*), is not distinguishable from the corresponding region of the scapula of a small Thousand Creek antelope, No. 11892, referred to *Ilingoceros*. A naviculo-cuboid, No. 22436 (fig. 45*b*), from the same locality as the scapula, also corresponds in size and form to small antelope naviculo-cuboid elements found at Thousand Creek and referred to *Ilingoceros*.

A tooth, No. 22435 (fig. 44*b*), found associated with astragalus 22434, corresponds to an upper molar of *Ilingoceros* or *Sphenophalos*.

A lower jaw with milk dentition and with $M\bar{1}$ in function, No. 22426 (fig. 44*a*), represents an antelope having approximately the size of the small forms of the Thousand Creek fauna. $M\bar{1}$ shows form and dimension close to those of specimens from Thousand Creek. In the milk dentition the characters are more advanced than those in *Merycodus* and in some respects more advanced than in *Capromeryx*. The teeth are larger and longer crowned than in *Merycodus* and the anterior lobe of $Dm\bar{4}$ is larger. Compared with *Capromeryx* the crowns of the milk teeth are not longer, but the anterior lobe of $Dm\bar{4}$ is larger. The inner side of $Dm\bar{3}$ possesses a postero-internal fold not present in *Capromeryx*, and there is an antero-internal fold on $Dm\bar{3}$ which is only

faintly marked on the corresponding teeth of the Rancho La Brea *Capromeryx*. In *Antilocapra* $Dm\bar{4}$ is not larger than in No. 22426, and the anterior lobe is relatively smaller. In *Antilocapra* $M\bar{1}$ has dimensions and form near those of No. 22426. Possibly the anterior lobe of $M\bar{1}$ in No. 22426 can be distinguished from that of *Antilocapra* by stronger inner curvature at the anterior end. The form of the mandible in No. 22426 in some respects approaches that in *Capromeryx* more closely than it does the outline of the only known antelope mandible specimen from the Thousand Creek beds. In the Thousand Creek specimen No. 22440, the ramus in the region of the diastema narrows comparatively little toward the anterior end. In *Capromeryx* the region of the diastema is relatively short and its height diminishes rather rapidly toward the anterior end. In Rattlesnake specimen No. 22426, the portion of the ramus in the region of the diastema is relatively narrow and slender. This may be due to a relatively early stage of development or it may be a distinguishing character. Young individuals of *Antilocapra* show relative slenderness in the region of the diastema, but no specimens have been examined in which the forward taper is as marked as in the Rattlesnake specimen.

A lower molar, No. 22445 (fig. 44*e*), associated with the small antelope astragalus No. 22443, resembles $M\bar{1}$ of mandible 22426 in form, but represents a somewhat larger animal. It is near the size of certain small lower cheek-teeth of antelopes from Thousand Creek but as in No. 22426 it may be narrower transversely and shows somewhat greater anterior prolongation of the anterior lobe. A portion of a lower $P\bar{4}$ or $P\bar{3}$, No. 22446, has a crown-pattern approaching that of *Antilocapra* in complication.

A large $M\underline{1}$, No. 22433 (fig. 44*c*), of an antelope, associated with a small scapula, No. 22432, and naviculo-cuboid, corresponds approximately in size and form to a tooth, No. 12605, from the Thousand Creek. In the Rattlesnake form the outer rib on the paracone seems more strongly marked. There is possibly a small difference in this character between No. 22433 and the Thousand Creek form, but the latter is nearer to No. 22433 than is *Antilocapra*.

Comparative measurements (in millimeters) of dentition.

	Ilingoceros or Sphenophalos, No. 22426.	Capromeryx, No. 19977.	Antilocapra, No. 8299, U. C. Mus. Vert. Zool.
$Dm\bar{2}$, antero-posterior diameter	5.5	4.2	....
$Dm\bar{2}$, transverse diameter	2.4	2	....
$Dm\bar{3}$, antero-posterior diameter	7.8	6	7.2
$Dm\bar{3}$, transverse diameter	4.1	2.7	3.7
$Dm\bar{4}$, antero-posterior diameter	14.5	9.6	12.1
$Dm\bar{4}$, transverse diameter	5.4	4	4.6
$M\bar{1}$, antero-posterior diameter	12.7	9.3	11.8
$M\bar{1}$, transverse diameter	5.6	4.2	6.1